THE CYTOEVOLUTION OF THE AUSTRALIAN PAPILIONACEAE

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(Plate XVI)

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Synopsis

Evolutionary development in the Australian Papilionaceae is analysed with special reference to the tribe Podalyrieae, through an integration of data on chromosome numbers, inflorescence morphology and geographic distribution.

Chromosome determinations are reported for 242 species of 22 genera in the Podalyrieae, together with 51 species of 13 genera from other tribes. The Podalyrieae is here divided into three groups on chromosome number and inflorescence morphology and the evolutionary pattern of each group has been analysed.

Base chromosome numbers of 7, 8 and 9 in the Podalyrieae originated prior to the development of the genera, which appear to have achieved pan-Australian distribution before mid-Miocene isolation of east and west. Only *Pultenaea* and *Dillwynia* developed strongly in the east. Polyploidy, including triploidy with variable pollen sterility in two species, is shown to be a minor factor in the evolution of the tribe. As in other hardwood families, aneuploid change of base chromosome number has been important.

In *Pultenaea* aneuploidy is associated with considerable morphological diversity, and ten groups of species are defined. Chromosome loss or gain was more frequent in regions where fluctuations in aridity had most profound effect, as in South Australia, while Victoria appears to have been a centre of survival and dispersal for most $x = 8$ species. On morphological evidence, this was the basic chromosome number of the genus, while $x = 7$ and $x = 9$ apparently had multiple origins in both east and west. The pattern of rapid speciation suggested for one *Pultenaea* group may indicate that "catastrophic" evolution permitted the success of *Pultenaea* above the other genera with more stable chromosome number.

INTRODUCTION

The family Papilionaceae of the Leguminosae comprises ten tribes according to Bentham (1864), but Hutchinson (1964) elevates most of Bentham's subtribes to tribes, bringing the total to fifty. The numerous genera are widely dispersed throughout both hemispheres in a great diversity of habitats and are well represented in Australia. In particular, the tribe Podalyrieae has shown extensive development in this country with 21 (according to Bentham (1864)) or 24 (according to Hutchinson (1964)) of its genera being endemic.

In the present paper an attempt is made to elucidate the probable evolution, or historical development, of the tribe Podalyrieae within Australia. The data from which the evolutionary inferences have been developed include cytological, morphological and distributional analyses.

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Material and Methods

Cytology

Cytological studies were made on anthers, ovaries and leaf buds fixed in acetic-alcohol (1:3) and stored in absolute alcohol at 4°C. Most mitotic counts were made from ovule wall tissue following three minutes hydrolysis in N.HCl at 60°C and staining with aceto-orcein. Some embryo and leaf bud mitoses were also studied. Meiotic observations were made on pollen mother cell divisions from aceto-orcein squash preparations. Pollen fertility was assessed by using acid fuchsin in a stain mountant of the formula proposed by Zirkle (1940).

Morphology

Of the approximately 475 species which are currently recognised in the Podalyrieae in Australia, all but 28 have been examined from specimens in the following herbaria: National Herbarium of New South Wales, Sydney (N.S.W.); Herbarium of the School of Biological Sciences, University of Sydney (SYD); Herbarium of C.S.I.R.O., Canberra and Waste Point (CANB); Herbarium of the Parks and Gardens Section, Department of the Australian Capital Territory, Canberra; National Herbarium of Victoria, Melbourne (MEL); State Herbarium of South Australia, Adelaide (AD); State Herbarium of Western Australia, Perth, (PERTH). Wherever possible use of fresh material has been preferred, particularly in determining whether absence of an organ is real or the result of abscission occurring at maturity.

A complete voucher collection is housed in SYD, and partial collections are available in NSW, AD and PERTH.

A preliminary survey of vegetative and inflorescence characters in representative species of the Podalyrieae was followed by selection of characters which either are constant within a genus or, in the case of *Pultenaea,* show variation between species. Observations on each species are tabulated in Sands (1966) together with descriptions of the inflorescence morphology characterising each genus or section thereof. Such data, summarised briefly below, provide the basis for the discussions on intergeneric and intrageneric relationships which follow.

Distribution

Species distributions have been assessed from the herbaria data, from State Floras and from the collections made during the course of this study.

Observations

Cytology

Chromosome Numbers

Chromosome numbers for 25 Australian species in seven genera in the family Papilionaceae have been reported previously (Table 1).

In the present investigation chromosome numbers of 242 species of 22 of the 24 genera in Hutchinson's (1964) classification of the Podalyrieae are reported, together with numbers for a further 51 species of 13 genera in other tribes. These include the Bossiaeeae of Lee (1973), previously Genisteae, the Indigofereae, Coluteae and Tephrosieae of Hutchinson (1964), all previously Galegeae, and the Glycineae and Cajaneae which were classified by Bentham (1864) as Phaseoleae. The study has included an extensive sampling of *Pultenaea,* the largest genus in the Podalyrieae (Plate XVI). Full details of the chromosome number determinations

TABLE 1

Previous records of chromosome numbers in Australian species of the Papilionaceae, tribes according to Bentham (1864)

Species	2n	State	Author
Genisteae			
Platylobium obtusangulum	16	SA	Oram, R. N. (unpubl.)
Crotalaria juncea	16	SA	Darlington and Wylie (1955)
Galegeae			
Swainsona canescens	?24	WA	Humphries, A. W. (unpubl.)
S. occidentalis	32	WA	,, ,,
S. cyclocarpa	32	WA	,, ,,
S. stipularis	32	WA	,, ,,
Phaseoleae			
Hardenbergia comptoniana	22	WA	Silsbury, J. H. (unpubl.)
H. violacea (as *H. monophylla*)	22	NSW	Smith-White, S. (unpubl.)
Kennedia beckxiana	22	WA	Silsbury, J. H. (unpubl.)
K. carinata	22	WA	,, ,,
K. coccinea	22	WA	,, ,,
K. eximia	22	WA	,, ,,
K. microphylla	22	WA	,, ,,
K. nigricans	22	WA	,, ,,
K. prorepens	22	WA	,, ,,
K. prostrata	22	WA	,, ,,
K. rubicunda	22	NSW	Smith-White, S. (unpubl.)
K. stirlingii	22	WA	Silsbury, J. H. (unpubl.)
Podalyrieae			
Daviesia brevifolia	18	SA	Oram, R. N. (unpubl.)
D. corymbosa	18	SA	,, ,,
Pultenaea gunnii	14	Tas.	Curtis (1952)
P. daphnoides	16	NSW	,, ,,
P. daphnoides var. *obcordata*	16	Tas.	,, ,,
P. stricta	16	Tas.	,, ,,
P. tenuifolia	16	Tas.	,, ,,
P. juniperina var. *juniperina*	18, 27, 36	Tas.	,, ,,
P. juniperina var. *planifolia*	18, 27	Tas.	,, ,,

are given in the Appendix with authorities for species names. Chromosome numbers are summarised at the generic level in Table 2. Karyotype analysis is not practicable. The chromosomes are generally small and do not show distinctive morphological features.

Meiotic Behaviour

Meiotic behaviour is normally regular but aberrations were noted in a few species. Residual bridge and fragment formation, sometimes accompanied by formation of an additional microcyte, or by subterminal neocentric activity or by reduction in the quantity of viable pollen produced, were observed in *Phyllota phylicoides, Dillwynia juniperina, D. parvifolia* var. *trichopoda, Pultenaea canescens, P. villosa* and *P. procumbens,* all with $n = 7$. In one specimen of *Oxylobium ilicifolium* ($n = 8$) "stickiness" of second metaphase chromsomes and occasional bridge formation were observed. These examples of irregular meiotic behaviour were infrequent and no population analyses were made.

Polyploidy

Polyploidy was found in 14 of the 242 species examined (Table 3). In *Pultenaea muelleri* var. *reflexifolia* the diploid and tetraploid plants were obtained from the one population but in the other species from

TABLE 2

Chromosome numbers of Australian genera of the Papilionaceae, following the classification of Hutchinson (1964)

Genus	No. of species studied	Total counts obtained	2n
Bossiaeeae ex Genisteae Benth. and Hook.f.			
Bossiaea	23	43	18
Goodia (Lee, 1973)	1	1	16
Hovea	9	28	18
Platylobium	1	7	16
Templetonia	1	3	16
Indigofereae ex Galegeae Benth. and Hook.f.			
Indigofera	3	11	16
Coluteae ex Galegeae Benth. and Hook.f.			
Swainsona	2	6	16, 32
Tephrosieae ex Galegeae Benth. and Hook.f.			
Tephrosia	1	1	16
Glycineae ex Phaseoleae Benth. and Hook.f.			
Glycine	1	3	20, 40
Hardenbergia	2	8	22
Kennedia	5	10	22
Cajaneae ex Phaseoleae Benth. and Hook.f.			
Rhynchosia	1	1	22
Podalyrieae			
Aotus	3	15	16
Brachysema	4	4	16
Burtonia	1	1	18
Chorizema	10	15	16, 32
Cupulanthus	1	1	16
Daviesia	28	65	18
Dillwynia	19	97	14, 28
Euchilopsis	1	2	14
Eutaxia	5	13	16, 32
Gastrolobium	18	29	16
Gompholobium	13	22	18
Isotropis	1	4	16, 32
Jacksonia	7	11	18
Latrobea	1	2	14
Leptosema	1	1	16
Mirbelia	11	27	16
Nemcia	7	14	16
Oxylobium	16	27	16
Pultenaea	89	283	8, 12, 14, 16, 18, 27, 28, 32
Phyllota	2	8	14
Sphaerolobium	3	4	18
Viminaria	1	2	18

different populations. In general a low frequency of multivalent formation at first metaphase was observed in tetraploid specimens. Pollen fertility was in the intermediate range wherever it could be assessed with the exception of complete pollen sterility in the single tetraploid determination of *P. linophylla*.

Twenty-two plants sampled in the only known population of *Dillwynia stipulifera* were all triploid. Meiotic material was not available but meiotic irregularity was suggested by the incidence of pollen sterility involving complete pollen breakdown. Fertility ranged from 5% to 90% with a mean of 30% for the 30 plants analysed. Re-establishment after fire suggested regeneration by root stocks. Insufficient plants survived

TABLE 3

*Incidence of polyploidy in the Podalyrieae**

Species	2n	4n	3n
Chorizema aciculare	1	1	
Dillwynia floribunda	8	3	
D. parvifolia var. *trichopoda*	4	3	
D. phylicoides	5	4	
D. prostrata		2	
D. retorta	5	2	
D. stipulifera			1
Eutaxia densifolia	1	1	
E. microphylla	6	1	
Isotropis cuneifolia	3	1	
Pultenaea dentata		1	
P. juniperina var. *juniperina*	1		
P. juniperina var. *planifolia*	4		4
P. linophylla	2	1	
P. muelleri var. *reflexifolia*	1	1	

* The figures in the body of the table represent the number of locations at which this particular level of ploidy was found.

and they were too small at the time of sampling to estimate the degree of variation within individual plants in the proportion of sterile pollen. For the same reasons the mechanism responsible for the high incidence of fertile pollen in some plants could not be investigated.

In the four collections of *Pultenaea juniperina* var. *planifolia* both diploid and triploid plants were obtained. The single plant of *P. juniperina* var. *juniperina* studied was diploid. Meiosis was regular in the diploid plants, but triploid plants showed considerable trivalent formation at first metaphase and lagging univalents at first and second anaphases. Pollen analysis of the populations near Sawpit Creek on the lower slopes of the Kosciusko Plateau showed that triploids had low pollen fertility but that there was a range of sterility among diploid plants greater than expected if meiosis had been completely regular (Table 4). Insect depredations thwarted study of seed set.

TABLE 4

Pollen analysis of three populations of Pultenaea juniperina *var.* planifolia*

% Fertility	Population K		Population M		Population J	
	2n	3n	2n	3n	2n	3n
100–90	7	—	3	—	—	—
89–70	2	—	1	—	—	—
69–50	3	—	3	—	1	—
49–30	1	—	2	—	—	—
29–10	2	2	1	—	3	2
9–0	1	3	4	—	3	12
No pollen	1	—	2	3	—	—

* The figures in the body of the table show the various pollen fertility ranges, with the number of 2n and 3n plants in each range.

Population K : Sawpit Creek walking track to Hatchery, 1·6 km from road.

Population M : Sawpit Creek track, 2·4–3·2 km from road, on opposite side of river.

Population J : Kosciusko roadside 1·6 km above Sawpit Creek, about 1,190 m.

TABLE 5
Chromosome and ovule numbers in the genera of the Podalyrieae, using the generic classification of Hutchinson (1964)

Chromosome base no.	No. of ovules	
	2	Variable 2–30
7	*Phyllota* *Euchilopsis* *Dillwynia* *Latrobea*	
8	*Eutaxia* *Aotus* *Gastrolobium*	*Oxylobium* *Nemcia* *Mirbelia* *Chorizema* *Isotropis* *Brachysema* *Cupulanthus* *Leptosema* *Jansonia*?
9	*Burtonia* *Sphaerolobium* *Jacksonia* *Viminaria* *Daviesia* *Erichsenia*?	*Gompholobium*
4, 6, 7, 8, 9	*Pultenaea*	

? denotes that generic relationships indicated by morphological studies have not yet been supported by cytological data for these monotypic genera.

Morphology in the Podalyrieae

The secondary taxonomic characters such as size and shape of organs and degree of pubescence were found to vary with age and within the environmental and geographical ranges of the species. Greater significance could be attached to features of the reproductive organs where character expression was much less altered by environment. These include inflorescence structure, the presence of floral leaves or of an involucre of sterile bracts, the form of the bract subtending each flower and of the bracteoles, pubescence of ovary and number of ovules.

The 24 Australian genera (Hutchinson, 1964) may be grouped according to the chromsome number and number of ovules characteristic of each genus (Table 5). Observations made on almost all species of the Podalyrieae are summarised below.

GENERIC GROUP I

A haploid complement of 9 chromosomes is found in six genera, all of which have 2 ovules and which comprise a great number of species. *Gompholobium*, also with $n = 9$, must be included with these on general morphological grounds despite its numerous ovules, as also must *Erichsenia*, although its chromosome number is not known.

The large genus *Daviesia* displays uniformity in many characters but diversity in leaf modifications and types of inflorescence. Its characteristic numerous bracts on the peduncles of all species and its scarious subtending bracts together with its typical pod shape and seed structure distinguish it from the monotypic *Viminaria* and *Erichsenia*. The three genera show similarities in the absence of bracteoles, orbicular floral standard, glabrous ovary with 2 ovules and strophiolate seeds.

Despite the varied modifications of cladode-type branches in *Jacksonia* which together with pod shape and thickness of ovule funicles separate it from *Gompholobium* and *Burtonia,* the 50 species of *Jacksonia* are relatively homogeneous in inflorescence and fruiting characters. These three genera all possess long calyx lobes, entire subtending bracts and bracteoles, and non-strophiolate seeds. *Gompholobium* and *Burtonia* can only be separated from each other by their differing number of ovules and direction of ovule funicles, both showing slight variability in other leaf and inflorescence characters. *Sphaerolobium* differs from *Jacksonia* mainly in habit, the form of the calyx lobes, glabrous ovary with style appendages and small stipitate globular pod. Interspecific differences are slight apart from variation in the style appendages.

Intrageneric uniformity appears to characterise this group of seven genera.

GENERIC GROUP II

With the exception of *Gompholobium,* genera possessing more than 2 ovules have a haploid complement of 8 chromosomes. The inclusion of *Gastrolobium* ($n = 8$ but 2-ovulate) in this complex is based on its similarity to *Oxylobium* series *Gastrolobioideae* (now the genus *Nemcia*), which has 4 or rarely 6 ovules. All species of both are similar in absence of bracteoles (neither bracteoles nor their scars were observed in *Gastrolobium* species, *contra* Bentham (1864)) and in seeds with strophioles. Some species in common possess similar inflorescence types, other trifid subtending bracts and stipulate leaves. In *Gastrolobium* series *Racemosae* leaves are stipulate and flowers in open or dense racemes or terminal clusters all have entire subtending bracts. In *Gastrolobium* series *Axillares,* however, while flowers are always in axillary clusters, one group of species has stipulate leaves and trifid subtending bracts (in a few species trifid lower bracts and entire bracts in the upper flowers of the inflorescence) and the other group has exstipulate leaves with entire subtending bracts.

Comparable patterns of overlapping variability are found within and between all the genera of this group. This is most evident in the large genus *Oxylobium*; the six series into which this genus was divided by Bentham (1864) show considerable similarities to other genera. *Oxylobium* series *Gastrolobioideae* (*Nemcia*) and series *Podolobieae* differ in the density of their racemes and in strophiolation of seeds but are distinct from the other four series in having 4 ovules and trifid subtending bracts, with bracteoles absent. *Oxylobium* series *Racemosae, Ericoideae, Callistachyae* and *Laxiflorae* have in common with *Mirbelia* the entire subtending bracts, bracteoles present with very few exceptions, and more numerous ovules which develop into nonstrophiolate seeds. The series may be separated on minor leaf and inflorescence characters, but while *Mirbelia* shows comparable diversity, it is consistently characterised by the false dissepiment dividing ovary and pod. *Chorizema* is also similar to these four *Oxylobium* series, but in some species has trifid subtending bracts reminiscent of the *Gastrolobium* trend, and shows leaf and stipule variation. Difference in habit, calyx form and size of pod distinguish this genus from *Isotropis.*

The monotypic *Jansonia* differs in a specialised bract arrangement, but is similar in its short narrow floral standard to the two sections of *Brachysema,* now defined by Hutchinson (1964) as three genera, namely, *Brachysema, Cupulanthus* and *Leptosema.* Despite lack of cytological confirmation, *Jansonia* must be included in this complex of genera. There is similarity between *Jansonia, Brachysema* section *Eubrachysema* (now *Brachysema sens. str.*) and *Oxylobium* series *Gastrolobioideae* (*Nemcia*), with stipulate leaves, trifid subtending bracts, lack of bracteoles and strophiolate seeds. By contrast, *Brachysema* section *Leptosema* (now *Leptosema*) resembles the four series of *Oxylobium* which have entire subtending bracts and bracteoles, and nonstrophiolate seeds.

It is evident that underlying the generic distinctions in this Group II, similar modifications in inflorescence structure occur repeatedly, giving rise to considerable morphological diversity at the intrageneric level. Interrelationships in the complex are close.

Generic Group III

Each genus in the third complex, characterised by 2 ovules, shows greater or less affinity with one of the groups of species in the large genus *Pultenaea.* Excluding the latter, the genera are similar in showing a trend towards solitary flowers, and in having an entire subtending bract and a pubescent ovary. Bentham's (1864) criterion of separation from *Pultenaea*, namely, absence of stipules, cannot be maintained, since vestiges of stipules are present in several species of *Eutaxia, Dillwynia, Aotus* and *Phyllota.*

Although many *Pultenaea* species have incurved or involute leaf margins, they are distinct, with their bracteoles adnate to or at the base of the calyx, from *Eutaxia, Dillwynia* and *Latrobea* with bracteoles attached below the calyx. The opposite leaves and haploid number of 8 of *Eutaxia* separate it from *Dillwynia* and *Latrobea* with alternate leaves and $n = 7$. The latter genera differ in size of calyx lobes and shape of the floral standard. Although there are minor differences between the two sections within each of these genera, there is considerable intrageneric uniformity in morphology.

Recurved and revolute leaf margins characterise other *Pultenaea* species and *Aotus, Phyllota* and the monotypic *Euchilopsis.* The latter, with $n = 7$, is distinct in size of calyx lobes. *Aotus,* with $n = 8$, scarious subtending bracts and lacking bracteoles, shows little specific diversification and is readily distinguished from *Phyllota* with $n = 7$ and leaf-like subtending bracts and bracteoles. There is integradation of the latter genus into a Western Australian group of *Pultenaea* species with $n = 7$ and exstipulate leaves, notably in leaf-margin curvature, union of staminal filaments with petals and reduction in number of flowers.

In this complex, morphological distinctions between genera with $n = 7$, or the two with $n = 8$, are greater than those between *Eutaxia* ($n = 8$) and *Dillwynia* ($n = 7$).

Pultenaea in Group III

The diversity of inflorescence structure in the very large genus *Pultenaea* is greater than that in any other genus of the Podalyrieae. Some significant features of the species are summarised in Tables 6 and 7. The infrageneric variability described below in these characters is of the same order as the differences which distinguish genera in the rest of the tribe.

Inflorescence Types

Where the stem continues growth during the flowering season, the inflorescence is frequently an open raceme with flowers so widely spaced as to appear solitary and axillary (Fig. 1a) or may be a shorter raceme with few flowers (Fig. 1c). In other species a compact raceme forms at the base of the new foliar growth or there may be axillary clusters

TABLE 6

Inflorescence characters, chromosome numbers and regional distribution of Pultenaea *species*

Group	Region	Inflor.	Invol.	Sub.br.	Br'ole	n	Ovary
I	E	LR	SL	SL	SL	8	Pu
II–1	W	,,	,,	,,	,,	—	,,
2	,,	,,	,,	SRL	En	—	,,
3	,,	,,	,,	En	,,	4	,,
III– 1	E	,,	,,	SL	,,	8	,,
a– 1	,,	,,	,,	,,	,,	8	,,
a– 2	,,	,,	,,	,,	,,	8	Tu
a– 3	,,	,,	,,	,,	,,	7	,,
a– 4	,,	,,	,,	,,	,,	7	Gl
b– 5	,,	,,	,,	,,	,,	9	Pu
b– 6	,,	,,	,,	SRL	,,	9	,,
b– 7	,,	DR	,,	,,	,,	8	,,
b– 8	,,	,,	SL–SRL	,,	,,	8	,,
b– 9	,,	,,	Tr	En	,,	8	,,
b–10	,,	,,	SL	SRL	,,	9	,,
b–11	,,	,,	SL–SRL	,,	,,	9	,,
c–12	,,	,,	,,	,,	Tr	8	,,
IV– 1	W	LR	SL	SL	SL	7	,,
2	,,	DR	,,	,,	SRL	7	,,
3	,,	,,	,,	,,	Tr	7	,,
4	,,	,,	,,	SRL	SRL	7	,,
5	,,	,,	SL–SRL	,,	En	7	,,
6	,,	,,	SRL	Tr	,,	7	,,
V– 1	,,	LR	SL	SL	SL	8	,,
2	,,	,,	,,	,,	,,	9	,,
3	,,	,,	,,	,,	En	—	,,
4	E	,,	,,	,,	,,	7	Tu
VI– 1	,,	,,	,,	,,	RSL	8	Pu
2	,,	,,	,,	,,	,,	7	,,
3	,,	,,	,,	,,	,,	7	Tu
4	,,	DR	,,	SRL	,,	8	,,
5	,,	,,	,,	,,	,,	8	Gl
VII–1	,,	LR	,,	SL	SL	7	Tu
2	,,	,,	,,	,,	SRL	7	,,
VIII	,,	DR	SL–SRL	SRL	En	8	Pu
IXa–1	,,	LR	SL	SL	,,	8	,,
a–2	,,	DR	,,	,,	,,	8	,,
a–3	,,	,,	,,	SRL	,,	8	,,
a–4	,,	,,	,,	Tr	,,	7	,,
a–5	,,	,,	SL–SRL	,,	,,	8	,,
b–6	W	,,	SL	SL	,,	—	,,
b–7	,,	,,	,,	SRL	,,	—	,,
b–8	,,	,,	Tr	En	En	—	,,
X–1	,,	,,	EL	EL	EL	7	,,
2	,,	LR	,,	,,	,,	7	,,

Key

I–X	Groups of *Pultenaea* species which are morphologically similar.
a–c	Subgroups of similar species in Groups III and IX.
1–12	Individual species or groups of species which are identical in the characters concerned.
E	Eastern Australia.
W	Western Australia.
Invol.	Involucre.
Sub.br.	Subtending bract.
Br'ole	Bracteole.
DR	Dense umbel-like raceme or few or solitary flowers surrounded by involucral bracts.
LR	Loose raceme, cluster or solitary flowers.
SL	Stipulate leaf.
SRL	Stipulate reduced leaf.
SL–SRL	Stipulate leaf on lower involucral bracts, stipulate reduced leaf on higher bracts.
RSL	Leaf with reduced stipules.
EL	Exstipulate leaf.
Tr	Trifid.
En	Entire.
Pu	Pubescent ovary.
Tu	Glabrous ovary with a tuft of apical hairs.
Gl	Glabrous ovary.
n	Haploid chromosome number ; (—) denotes number not determined.

TABLE 7

Species Groups in Pultenaea

GROUP I
P. trifida, P. quadricolor, P. d'altonii

GROUP II
1 *P. ochreata*
2 *P. aspalathoides*
3 *P. reticulata*

GROUP III
1 *P. tenuifolia, P. prolifera, P. fasciculata, P. teretifolia, P. canaliculata, P. trinervis, P. trichophylla, P. villifera, P. viscidula, P. graveolens, P. densifolia, P. patellifolia*

Subgroup (a)
1 *P. blakelyi*
2 *P. flexilis*
3 *P. campbellii*
4 *P. euchila, P. altissima, P. obovata*

Subgroup (b)
5 *P. acerosa, P. rigida, P. vrolandii*
6 *P. juniperina, P. costata*
7 *P. bauerlenii, P. subalpina*
8 *P. divaricata, P. echinula, P. largiflorens*
9 *P. involucrata, P. muelleri, P. prostrata*
10 *P. viscosa, P. mollis, P. angustifolia*
11 *P. hibbertioides*

Subgroup (c)
12 *P. incurvata, P. paludosa, P. cambagei, P. subumbellata*

GROUP IV
1 *P. empetrifolia*
2 *P. vestita*
3 *P. adunca*
4 *P. radiata*
5 *P. verruculosa*
6 *P. ericifolia, P. strobilifera*

GROUP V
1 *P. calycina*
2 *P. obcordata*
3 *P. tenella, P. rotundifolia, P. arida, P. cymbifolia, P. spinulosa*
4 *P. cunninghamii, P. subternata, P. spinosa*

GROUP VI
1 *P. laxiflora*

Subgroup (a)
2 *P. hispidula, P. recurvifolia, P. pubescens*
3 *P. villosa*

Subgroup (b)
4 *P. stipularis, P. aristata*
5 *P. glabra*

GROUP VII
1 *P. procumbens, P. boormanii, P. foliolosa, P. stuartiana, P. ferruginea, P. setulosa*
2 *P. canescens, P. elliptica, P. subspicata, P. parviflora, P. humilis, P. weindorferi*

GROUP VIII
P. dentata

GROUP IX

Subgroup (a)
1 *P. pedunculata, P. hartmannii, P. microphylla, P. scabra, P. milleri,*
2 *P. petiolaris*
3 *P. benthamii, P. selaginoides*
4 *P. gunnii*
5 *P. paleacea, P. myrtoides, P. capitellata, P. pycnocephala, P. stricta, P. maidenii, P. rosmarinifolia, P. daphnoides, P. mucronata, P. polifolia, P. linophylla, P. retusa, P. amoena, P. platyphylla*

Subgroup (b)
6 *P. skinneri*
7 *P. conferta, P. drummondii*
8 *P. pinifolia*

GROUP X
1 *P. capitata, P. dasyphylla, P. lycopodioides, P. andrewsii, P. georgei*
2 *P. neurocalyx*

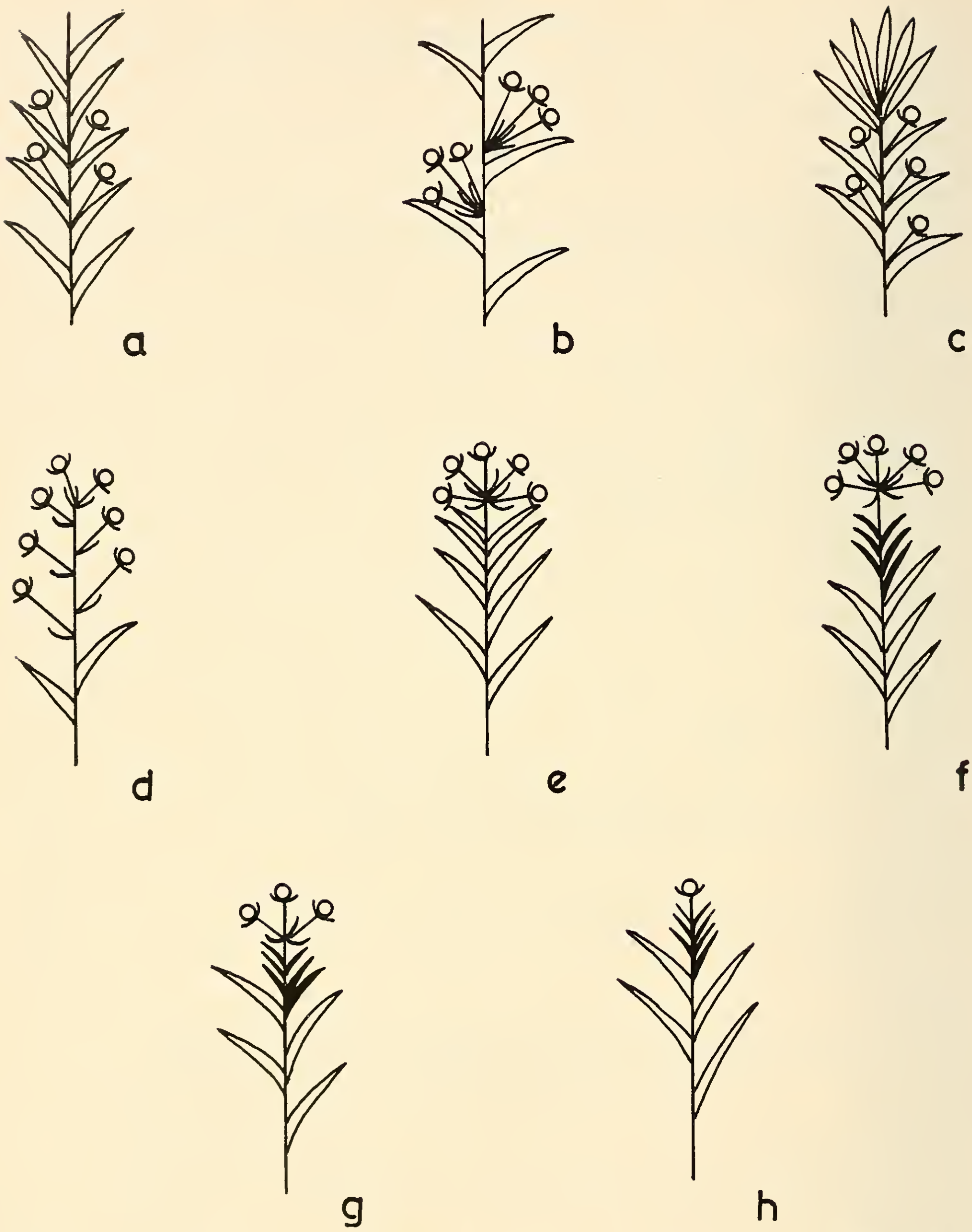

Fig. 1. Variations in inflorescence structure in *Pultenaea*. "Open" structure: a. Open raceme with stem growth continued during flowering season. b. Axillary clusters at the base of new foliar growth, sessile or terminal on short lateral shoots. c. Few-flowered raceme with dense foliar growth during flowering season. "Closed" structure: d. Loose terminal raceme with no stem growth during flowering season. e. Dense umbel-like terminal raceme surrounded by floral leaves. f. Dense terminal raceme surrounded by involucre of sterile bracts. g. Terminal cluster surrounded by involucre of sterile bracts. h. Solitary flower surrounded by involucre of sterile bracts.

(Fig. 1b) or solitary flowers. In all such inflorescences each flower is subtended by a normal stipulate leaf.

Where stem proliferation ceases with flowering, the inflorescence may be a more open terminal raceme (Fig. 1d), a dense terminal raceme with peduncles attached to the stem very close together giving an umbel-like appearance (Fig. 1e, f), or may be reduced to a cluster (Fig. 1g) or to solitary flowers (Fig. 1h). Whatever their form, such terminal inflorescences are surrounded either by a dense whorl of floral leaves (Fig. 1e) or in certain *Pultenaea* species, by an involucre of sterile bracts (Fig. 1f, g, h).

BRACTS AND BRACTEOLES

The normal stipulate leaf or bract subtending each flower is a "deckblatt" in the sense of Troll (1957) and Goebel (1931) and is called the "subtending bract" in this study.

Gradation of bract development prevents sharp distinction between those species of *Pultenaea* with floral leaves at the base of the inflorescence (Fig. 1e) and those with an involucre (Fig. 1f). In the latter the involucral bracts are consistently less modified than the subtending bracts of the flowers above. In all species of *Pultenaea* the floral leaves are inserted on the stem in closer proximity to one another than are the vegetative leaves and their stipules are enlarged and often coherent for almost their entire length. The reduction in stipules on vegetative leaves in some species is accompanied by comparable reduction on the subtending bracts (Fig. 2b). Other species entirely lack stipules in vegetative and floral leaves, subtending bracts and bracteoles (Fig. 2a).

Four species of *Pultenaea* have racemes or clusters of flowers surrounded by floral leaves, and both subtending bracts and bracteoles are normal leaves with enlarged stipules (Fig. 2d). More commonly, however, the floral or bract leaf is reduced to a pubescent lanceolate structure attached externally at the base of the large stipules (Fig. 2e), as is the normal leaf, or even higher up towards the point of cohesion of the stipules (Fig. 2f). The subtending bract may be similar to the floral leaf and the bracteoles either trifid and three-veined (Fig. 2g) or entire with only a mid-vein (Fig. 2h). Alternatively the subtending bract may be trifid and the bracteoles entire; in this case the involucre is normally separate from the leaves below. The three *Pultenaea* species which have only one to three flowers enclosed in a distinct involucre have trifid involucral bracts and entire, single-veined subtending bracts and bracteoles.

Pubescence

Consistency of pubescence within a species is observed only in the ovary. The surface may be densely pubescent, glabrous with an erect tuft of bristles on the more rounded side towards the apex, or entirely glabrous. Degree of pubescence sometimes differs between species with an otherwise close morphological relationship.

Distribution

With the exception of four monotypic genera, two larger genera and several sections of genera which are endemic to the west, species of the remaining genera of the Podalyrieae in Australia are distributed throughout the western and eastern Temperate regions and the borders of the southern Eremaean region. A few are found in refugial areas in the Tropical Zone and in Central Australia.

Discussion

Classification

Bentham's (1864) classification of the genera of the Podalyrieae is in accord with the karyological data (see Appendix) but the gross morphology of the inflorescence (Sands, 1966) supports the further generic divisions of *Oxylobium* and *Brachysema* proposed by Hutchinson (1964).

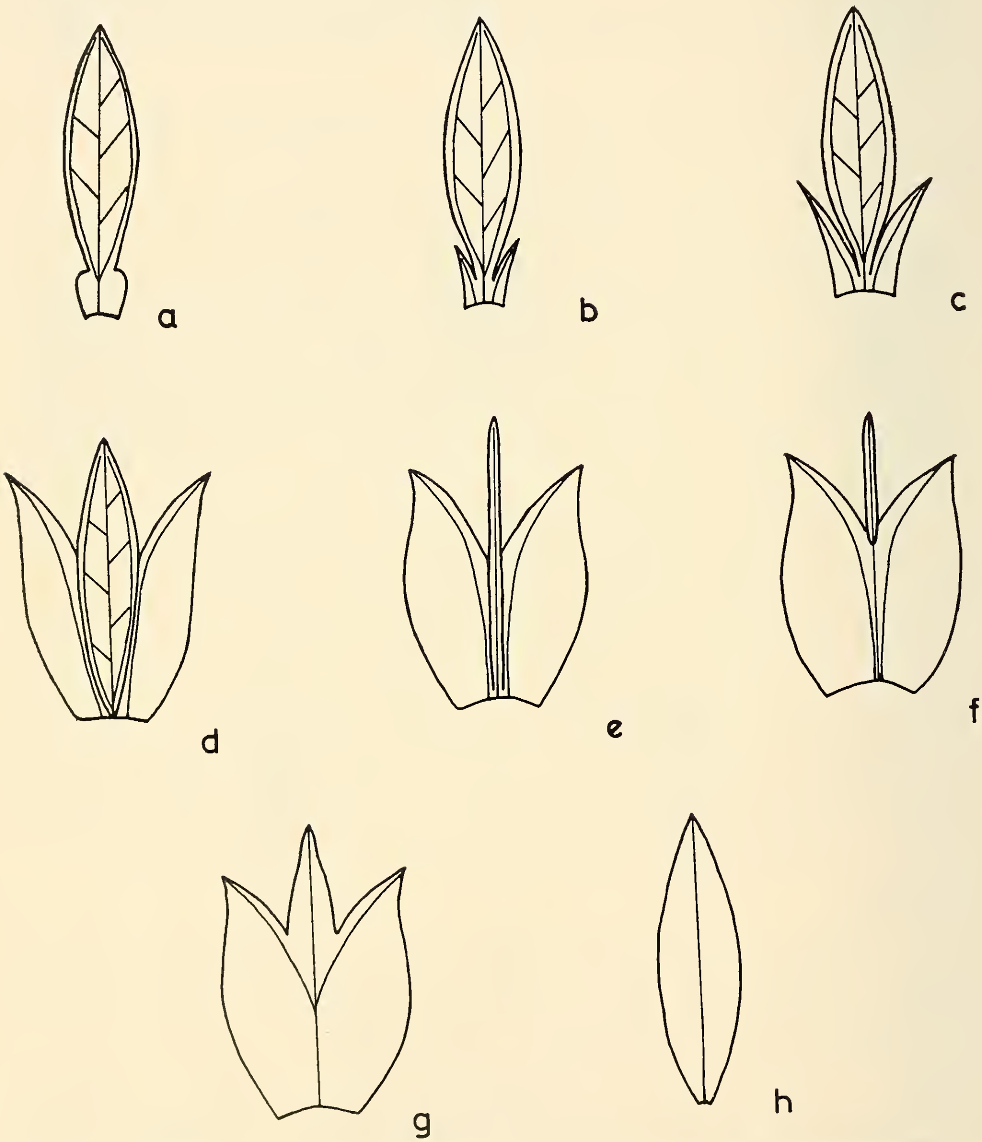

Fig. 2. Variation in bracts and bracteoles in *Pultenaea*. a. Extipulate leaf or bract (EL). b. Bract or bracteole with stipules reduced (RSL). c. Bract or bracteole with normal stipules (SL). d. Bract or bracteole with enlarged stipules (SL). e. Bract leaf reduced, attached basally to enlarged fused stipules (SRL). f. Bract leaf very reduced, attached near point of cohesion of fused stipules (SRL). g. Bract or bracteole trifid (Tr). h. Bract or bracteole entire, single-veined (En).

On the basis of these data it is possible to divide the tribe Podalyrieae into three major groups of genera:

Group I *Gompholobium, Burtonia, Sphaerolobium, Jacksonia, Viminaria, Daviesia* and probably *Erichsenia.*

Group II *Gastrolobium, Oxylobium, Nemcia, Mirbelia, Chorizema, Isotropis, Brachysema, Cupulanthus, Leptosema* and probably *Jansonia.*

Group III *Pultenaea, Phyllota, Aotus, Euchilopsis, Eutaxia, Dillwynia* and *Latrobea.*

Pultenaea may only be distinguished from the remainder of the Podalyrieae by a number of characters, no one of which is sufficient alone for definition. The complexity of this genus with approximately 120 species is greater than suggested by Bentham's (1864) delineation of it into four sections. Leaf arrangement is consistent within each species and effectively distinguishes section *Euchilus,* while marked venation delimits section *Aciphyllum.* However, in his other two sections, *Coelophyllum* and *Eupultenaea,* curvature of leaf margins is of limited use as a criterion of distinction.

When such vegetative characters as Bentham (1864) employed are correlated with modifications in inflorescence and bracts, with degree of ovary pubescence and with chromosome number, ten groups of species may be distinguished (Table 7). There is overlap from one group to another in this integrading plexus of species and the discontinuity between any two groups rests on one character only (Table 6). The continuous variation of morphological characters confirms the taxonomic integrity of the genus.

Recognised Trends in Morphology

It is possible to analyse further the morphological variation between genera, and particularly between species of *Pultenaea,* in terms of the evolutionary trends recognised in other Angiosperm families and of the generally accepted principles of modification and advancement.

Sporne (1948) and Zimmerman (1959) consider that opposite or whorled leaves have generally been derived from spirally arranged or alternate leaves. Incurved leaves with exposed stomates presumably have lower selective value during times of increased aridity than do flat or recurved leaves, while involute leaves would be even less susceptible to environmental change. Physiological adaptability of vegetative organs is evident in the great range of leaf modifications in the Podalyrieae and must have permitted survival and diversification of these genera under variable and extreme conditions. This is demonstrated in the large and widespread genera *Daviesia, Jacksonia* and *Pultenaea.*

In recent decades the Ranalian concept of Angiosperm evolution has been widely accepted. In particular, the current consensus is that there has been progressive reduction in number of ovules (Stebbins, 1950; Bailey, 1954; Hutchinson, 1959; Barnard, 1961) and that the solitary-flowered condition has been derived from many-flowered inflorescences (Takhtajan, 1959), with compact inflorescences having greater selective value for efficiency of pollination.

Particular trends in development of racemose inflorescences are outlined by Troll (1957, 1964) and are clearly exemplified in the genus *Pultenaea.* He suggests that the "open" raceme with active growing point may by loss of this growth become a "closed" raceme. Sharp reduction in the number of flowers may lead to a short raceme or "in extreme cases can extend even to a solitary flower, as among the Papilionaceae". Alternatively, the floral stem internodes may be reduced to give a dense raceme resembling an umbel either with a proliferating apex or a terminal flower.

The species of *Daviesia* further illustrate such sequences. The unusual and consistent bract arrangement may indicate the ancestral inflorescence of the genus. Each flower in any type of inflorescence is subtended by a bract and below this on the peduncle are other small alternately placed bracts, often more closely clustered towards the base. These are never present on the pedicels of an umbel, raceme or axillary cluster, which suggests that loss of flowers from a primitive loose raceme or condensation of the upper peduncles gave rise to the existing modifications. The rudiments of subtending bracts may be observed opposite the bracts which subtend the solitary flowers in *Gompholobium* and following the interpretation of Troll (1957) may be taken to indicate earlier racemose structure. In all the genera except *Jansonia* and *Eutaxia* at least some of the species have the primitive racemose inflorescence, which therefore should be regarded as the basic inflorescence in the ancestral Podalyrieae stock.

Takhtajan (1959) considers that a gradation from a whorl of floral leaves to an involucre of sterile bracts surrounding the dense racemose heads of flowers, as found in many species of *Pultenaea,* indicates a trend from primitive to more advanced, as does the reduction of vegetative leaves to form bracts. In the three species with single flowers surrounded by involucral bracts there may have been loss of the basal flowers of a large raceme. This formation of an involucre occurs in *Pultenaea* species which show the greatest modification of subtending bracts and bracteoles. Without exception the subtending bracts are similar to or more modified, by reduction of parts, than the involucral bracts and the bracteoles are the same as or more reduced than the subtending bracts. In *Gastrolobium* series *Axillares* certain species show the same progression from trifid subtending bracts at the base of the inflorescence to entire bracts towards the apex.

The transition from a stipulate leaf to an entire, and at maturity, scarious bract, may have occurred by reduction of stipules to minute vestiges or to the point where the leaf was exstipulate. In the other direction, enlargement and cohesion of the stipules, allied with progressive reduction of the leaf and its fusion with the stipule structure as described by Takhtajan (1959), appears to have occurred in many species of *Pultenaea.*

In *Pultenaea* the open racemose, clustered or solitary-flowered conditions are associated with the less modified types of bracts and also with differences in the degree of ovary pubescence. The closed or umbel-like raceme, by contrast, is generally found together with reduced subtending bracts and bracteoles and with development of an involucre of sterile bracts. Species with this dense inflorescence are characterised by a pubescent ovary, thought by Stebbins (1950) to represent a more primitive condition.

Basic Chromosome Number

PAPILIONACEAE

A basic chromsome number of 4 was first suggested for this family by Wanscher (1934) using the doubtful evidence of secondary association. Senn (1938) contended that $x = 8$ was primitive because of its frequency of occurrence in the great proportion of species of all tribes of the Papilionaceae and emphasised the largely intergeneric nature of secondary change in the family. Stebbins (1966), Raven and Kyhos (1965), Ehrendorfer *et al.* (1968) and Raven *et al.* (1971) provide evidence in support of Darlington and Mather's (1949) postulate of 7 as the primitive haploid number of the Angiosperms, with aneuploid and polyploid derivation of higher numbers in many woody Angiosperm families.

The complement of 7 is well represented in the Papilionaceae but $x = 8$ and $x = 11$ are basic to the cytoevolution of certain tribes and series. The additional chromsome numbers obtained in this survey have not provided critical evidence in support of these hypotheses. They conform to the chromosomes numbers obtained for extra-Australian genera within their respective tribes with the exceptions of $n = 9$ in the numerous species of *Bossiaea* and *Hovea* (Bossieeae) $2n = 16$ for *Tephrosia* (Tephrosieae), and $n = 4$, 6, 7, 8 and 9 in the Podalyrieae. Cytological data is insufficient for the elucidation of the cytoevolution of the Papilionaceae.

PODALYRIEAE

Although Senn (1938) suggested that the Podalyrieae may have been derived from a primitive stock in the Sophoreae with the majority of its genera having a haploid complement of 9 chromosomes, he favoured $x = 8$ as the basic number of the Podalyrieae because of the preponderance of this number in several of the other tribes.

Of the eight genera of the Podalyrieae which occur in South Africa, Asia and North America, five, namely *Baptisia* Vent., *Anagyris* Linn., *Podalyria* Lam., *Piptanthus* Sweet and *Thermopsis* R. Br. ex Ait., are known to have a diploid complement of 18 chromosomes (Darlington and Wylie, 1955; Index to Plant Chromosome Numbers 1956–1964). This wide and disjunct distribution is probably indicative of their ancient origin and of the primitiveness of $x = 9$ but does not necessarily imply that this haploid number was basic to the evolution of the Australian genera. Polyphyletic origin of the tribe was suggested by Dormer (1945, 1946) following his study of the phyllotaxy and vascular systems of representatives from northern and southern hemispheres and comparison between the South African genera and a few of the Australian genera. This may be supported by the fact that all but one of the Australian genera with $x = 9$ have 2 ovules, while the extra-Australian genera have numerous ovules. It could be inferred, however, that early colonising stocks in Australia with 9 haploid chromosomes and numerous ovules were replaced by the derived species to which they gave rise.

It is evident that morphological and cytological study of the extra-Australian genera is required to elucidate the evolution of the tribe. Chromosome investigations and interpretation of the gross morphology in terms of accepted evolutionary trends indicate a monophyletic origin of the 24 Australian genera. Haploid complements of 7, 8 and 9 have been determined in these genera and with the exception of the genus *Pultenaea* there were no intrageneric differences in base number. It can be inferred that the base numbers were established prior to the origin of the other genera.

External morphology of the genera in Group I reveals a general uniformity of characters within genera associated with certain marked intergeneric discontinuities—a pattern indicative of age both of the genome and of the genera. Reduction in number of ovules to 2 must have occurred early in the differentiation of the genera. Group II genera have comparatively primitive inflorescence morphology with repeated occurrence of similar modifications. They show a morphological pattern with close relationships between genera and extensive specific diversification. This suggests a single origin of $x = 8$ prior to the development of the genera.

The lack of decisive non-overlapping distinctions between the Group III genera, with their reduced number of ovules and rather more advanced inflorescence characters, suggests a common ancestral stock. Chromosomal and morphological inter-relationships indicate multiple origins of the base numbers 7 and 8 within this complex. For example, *Phyllota* ($n = 7$) shows very close affinity to certain *Pultenaea* species with $n = 7$; *Eutaxia* ($n = 8$) is morphologically more similar to *Dillwynia* ($n = 7$) than to the other genera with $n = 8$. Excluding *Pultenaea,* differentiation between species within these four genera is not great and this lack of diversification at the level of both genera and species indicates either more recent origin or less potential for differentiation.

From these evolutionary patterns there is thus some evidence that 9 was the basic chromosome number of the Australian Podalyrieae, but $x = 8$ is clearly also very ancient. Reduction in number of ovules appears to have been basic to the development of the genera with 9 chromsomes, to have had considerable significance in one group of $x = 8$ genera and to be confined to one genus in the other group.

The geographic distribution of the tribe provides further indications of its development in Australia but not of its origin. The few known papilionaceous fossil types (Duigan, 1951; Cookson and Pike, 1954) do not provide significant information concerning past distribution. Present general east-west Temperate distribution in Australia suggests that the majority if not all the genera, and in consequence their 7–, 8– and 9–genomes, were in existence prior to the mid-Miocene isolation of east and west caused by the inundation of the Nullabor region (Crocker and Wood, 1947; David, 1950). The six species restricted to the South-West Province of Western Australia and of South Australia must be relics of this earlier broad distribution as also must certain other species with disjunct distribution across the north. Island movement of the winter rainfall belts into inland South Australia following the first Arid Phase may have permitted northern migration of the few species now isolated in Central Australia (Burbidge, 1960).

Pliocene uplift possibly provided a spur to differentiation in the west where with the exception of *Pultenaea* and *Dillwynia* all the genera show their major development. Species which were vegetatively adapted to relative dryness, e.g., *Jacksonia* and *Daviesia,* would be able more readily to tolerate the aridity of the Pleistocene and to take advantage of the subsequent denudation. In the eastern Temperate region *Dillwynia* and *Pultenaea* comprise some 60% of all species of Podalyrieae, and were more successful under the conditions brought about by the mountain building and coastal uplift of the late Pliocene and by later climatic changes.

Pultenaea

Within the genus *Pultenaea* Curtis (1952) found base numbers of 7, 8 and 9, and the present work confirms her findings with the determination of eight species with $x = 9$, 48 with $x = 8$ and 31 with $x = 7$. In addition single species with $x = 6$ and $x = 4$, respectively, were found.

This range of chromosome numbers may be an example of development of secondary base numbers as described by Darlington (1937) and demonstrated in *Crepis* by Tobgy (1943) and others. The 4 haploid chromosomes of *P. reticulata* may be the end product of such a reduction series. Alternatively the complement could be primitive and $x = 8$ a secondarily derived tetraploid base number, which had an evolutionary potential for establishing a new diploid level. $x = 4$ may on the other hand be the product of a rare reversion of polyploidy (Kimber and Riley, 1963; Raven and Thompson, 1964; De Wet, 1971), a mechanism which would account for its preservation in a region where chromosome number change has been rife.

The great morphological variability in *Pultenaea* is associated with this change in chromosome number. In eastern species of *Pultenaea* $n = 8$ occurs with a considerable range of bract and inflorescence types whereas $x = 7$ and 9 are correlated with the more advanced or derived condition and with little alteration of flower or inflorescence other than in ovary pubescence. In the west, on the other hand, 7 is the haploid number most frequently observed in conjunction with all degrees of inflorescence development and modification of parts. Complements of 8 and 9 chromosomes occur only in the morphologically primitive species of Group V.

$x = 7$ appears to have been derived separately in eastern and western regions and is associated in all but one species with some modification of inflorescence structures in different sequences of morphological advancement rather on the periphery of the main evolutionary trends. $x = 9$ also is most frequently associated with morphological modifications and has certainly originated twice despite its sparse representation. These features indicate that the complements of 7 and 9 haploid chromosomes in *Pultenaea* were derived from a basic number of $x = 8$, this being associated generally with greater variability in a larger number of species, and with both primitive and advanced morphological features. Possibly the ancient complement of 8 represents an example of the cryptic polyploidy described by Stebbins (1950) for other families of the Angiosperms. Whatever the derivation of the $n = 4$ of *P. reticulata*, $x = 8$ was undoubtedly the most significant chromosome complement, whether as a primary or secondary base number, for the genus.

In *Pultenaea* there are distinct eastern and western sequences of morphological differentiation and several of the groups are confined to a single region. In addition, change of chromosome number has been more frequent in those regions where aridity had most profound effect. In the western representatives this is evidenced by complements of $n = 4$ in Group II, $n = 7$ in Group X, $n = 7$ and 8 in Group IV and $n = 8$ and 9 in Group V. In the east, $n = 7$ occurs predominantly among the generally more broad-leaved species of Queensland and New South Wales, i.e., Groups VI, VII and III(a), all morphologically distinct from the western groups with $n = 7$. $n = 9$ on the other hand is characteristic of Groups III and III(b), both found mainly in South Australia.

It appears that Victoria, which was less affected by climatic change, has been a centre of survival and dispersal for the majority of eastern species characterised by $x = 8$. Apart from a few species which are morphologically distinct and restricted in distribution, Victorian species are either closely related in primitive morphology to those occurring in neighbouring States or are represented there.

The effects of isolation and aridity on speciation in *Pultenaea* are evident in South Australia. The restriction of species to the coastal zones and mountain ranges in the 500 mm annual rainfall belt presumably followed the general dispersion during the moist subtropical climate of the Pliocene, the elevation of mountain ranges and of the Gulfs above sea level with colonisation of newly available habitats and the later resubmergence of the sunklands with isolation of species. The "Great" arid period of early Recent times (Crocker and Wood, 1947) destroyed all but a few relict species of this early broad distribution which were able to survive in these refugial areas, e.g. the 12 endemic species of *Pultenaea* at the western end of Kangaroo Island. Such refugia were doubtless centres of speciation during the differential separation of the peninsulas from the island (Wood, 1930), centres of survival during the arid phases and centres of dispersal during intermittent pluvial periods (Burbidge, 1960). This dispersal, together with waves of migration of species from Victorian refugia, is considered by Crocker (1959) to account for major recolonisation of south-eastern South Australia. Rapid separation would certainly be possibly following the relaxation of selection pressures as relict and migrant species extended over denuded areas (Wright, 1949), a situation of which *Pultenaea* appears to have taken advantage.

The Development of the Podalyrieae in Relation to other Australian Families

The pattern of evolutionary development in the Podalyrieae conforms to that outlined by Smith-White (1959) for five other Australian hardwood families of the Temperate Zone, namely, the Myrtaceae (Smith-White, 1950, 1954*a*), Epacridaceae (Smith-White, 1955*a*, 1959), Rutaceae (Smith-White, 1954*b*), Proteaceae (Ramsay, 1963) and Casuarinaceae (Barlow, 1959*a*, *b*). Geographical expansion and diversifaction during the Early Tertiary must have brought about the establishment of the present-day genera of the Podalyrieae across the continent since the great majority of genera are common to both eastern and south-western Australia. Chromsome number changes within each genus have been few since the mid-Miocene, a situation comparable to that in other hardwood families. However, to some extent polyploidy and aneuploidy have furthered evolutionary processes in the development of the Podalyrieae.

POLYPLOIDY

The occurrence of polyploidy in certain Australian herbaceous families, namely Lobeliaceae (James, 1963; McComb, 1968), Goodeniaceae (Peacock, 1962, 1963), Compositae (Smith-White *et al.*, 1970) and Graminae (Hayman, 1960; Brock and Brown, 1961), and to a lesser extent in hardwood genera such as *Casuarina* (Barlow, 1959*a*, *b*), *Cassia* (Rendell, 1970) and *Eremophila* (Barlow, 1969, 1971), has been interpreted as a response to geological and climatic changes during the late Tertiary or Quaternary. In the Podalyrieae polyploidy is of infrequent occurrence and is mainly or entirely intraspecific as in the above herbaceous families. Population sampling of the eastern species of *Dillwynia* which showed tetraploidy may reveal a geographic pattern of distribution of polyploid races similar to that in certain genera of the Goodeniaceae. It is clear however that polyploidy has been a recent specialisation in the Podalyrieae, making only a minor contribution to the evolution of genetic systems in the tribe.

An interesting sideline, of no profound evolutionary significance, is found in the two species in which a triploid system has developed and been maintained. In neither case is there any evidence of a permanent balanced triploidy comparable to that of the *Rosa canina* complex (Stebbins, 1950) or of *Leucopogon juniperinus* (Smith-White, 1955*b*), though in contrast to the restricted distribution of *Dillwynia stipulifera, Pultenaea juniperina* has widespread and disjunct distribution with diploids and triploids occurring together. Further study of these two species with regards to the origin and maintenance of the triploid condition, and of aberrant diploid behaviour in *Pultenaea juniperina,* is clearly warranted.

ANEUPLOIDY

The development of secondary base numbers appears to have been a most significant genetic mechanism in the cytoevolution of a number of Australian hardwood families. It is reported in Myrtaceae (Smith-White, 1950, 1954*a*), Boronieae of the Rutaceae (Smith-White, 1954*b*), Epacridaceae (Smith-White, 1955*a*), Casuarinaceae (Barlow, 1959*a*), Proteaceae (Ramsay, 1963), and in *Brachycome* of the Compositae (Smith-White *et al.,* 1970). A comparable aneuploid sequence involving $n = 9$, 8 and 7 appears to have preceded the origin of the genera in the Podalyrieae in Australia. And in more recent times the evolution of the largest genus in the tribe is correlated with aneuploidy.

The genus *Pultenaea,* with its many species having different chromosome numbers, is the notable exception to the intrageneric stability of chromosome numbers observed in the Podalyrieae. The greatest morphological diversification in *Pultenaea* appears to have occurred in regions which have suffered profound changes in environmental conditions, such as the Recent aridity in South Australia. Such changes would bring about plant migration, species diminution or extinction, survival in refugia, back-migration under more favourable conditions and recolonisation of denuded areas. Repeatedly, new biotypes would find themselves at the margin of a species range or in small isolated peripheral populations. If they possessed the potential to occupy new territory then the new adaptive biotypes could have been conserved by change of base number of chromosomes.

Aneuploidy is a mechanism by which the recombination rate may be lowered through the suppression of crossing-over and also by which reproductive isolation from the parental population could be achieved. Such a change in the genetic system will, if it has positive adaptive value so that it is selected for strongly, lead to speciation. Chromosome number differences are associated with morphological diversity in present-day species of *Pultenaea,* with multiple origins of haploid complements of 7 and 9 chromosomes being indicated by the differing patterns of morphological variability. Further, these species grow in regions where considerable climatic and geological changes have occurred since the Miocene Period. Aneuploidy must therefore have made a significant contribution to the evolution of this genus with its complex of intergrading species.

The evolution of the Group III(a) species of *Pultenaea* may provide an example of such a process. *P. flexilis* ($n = 8$) with glabrous ovary with tuft of apical hairs, exhibits considerable morphological diversity and *P. blakelyi* ($n = 8$) differs only in its pubescent ovary. The other four species with $n = 7$ show small size and shape variations and further reduction in ovary pubescence to tufted in *P. campbellii* and glabrous in *P. euchila, P. altissima* and *P. obovata.* The marginally overlapping geographic distribution of these species (Figure 3) resembles the pattern reported by Lewis (1962) for various species of *Clarkia.* He considers

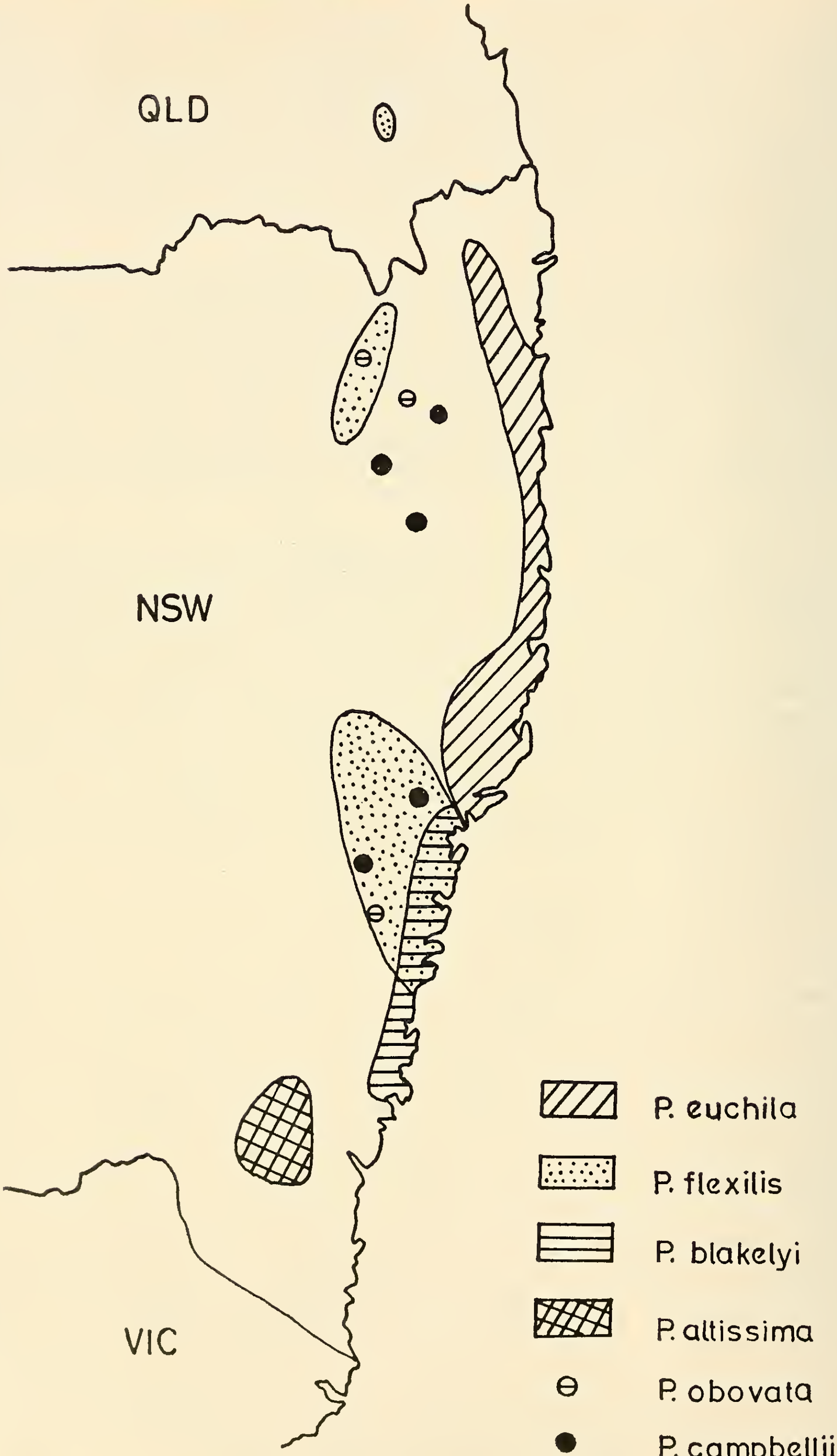

Fig. 3. *See legend on opposite page.*

that "the drastic alteration of genetic background in newly founded peripherally isolated populations has produced rapid speciation". Study of breeding mechanisms, incompatibilities, fertility of interspecific hybrids and karyotype analyses may reveal whether there are strong internal barriers to gene exchange between these *Pultenaea* species, which are not herbaceous as are all the examples quoted by Lewis (1962). If such barriers exist then the indications of rapid speciation noted by Stebbins (1950) are all in evidence.

Such "catastrophic" evolution may have been partially responsible for the evolutionary success of *Pultenaea* under conditions which decimated the more genetically inflexible genera in eastern Australia. Further, it may provide a model of the early evolution of the other genera of the Podalyrieae following the establishment of the tribe in Australia during the Cretaceous Period.

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Fig. 3. Distribution of certain species of *Pultenaea* Group IIIa in Queensland and New South Wales. *P. blakelyi*, $n = 8$, ovary pubescent; *P. flexilis*, $n = 8$, ovary glabrous with a tuft of apical hairs; *P. campbellii*, $n = 7$, ovary glabrous with a tuft of apical hairs; *P. euchila*, $n = 7$, ovary glabrous; *P. altissima*, $n = 7$, ovary glabrous; *P. obovata*, $n = 7$, ovary glabrous.

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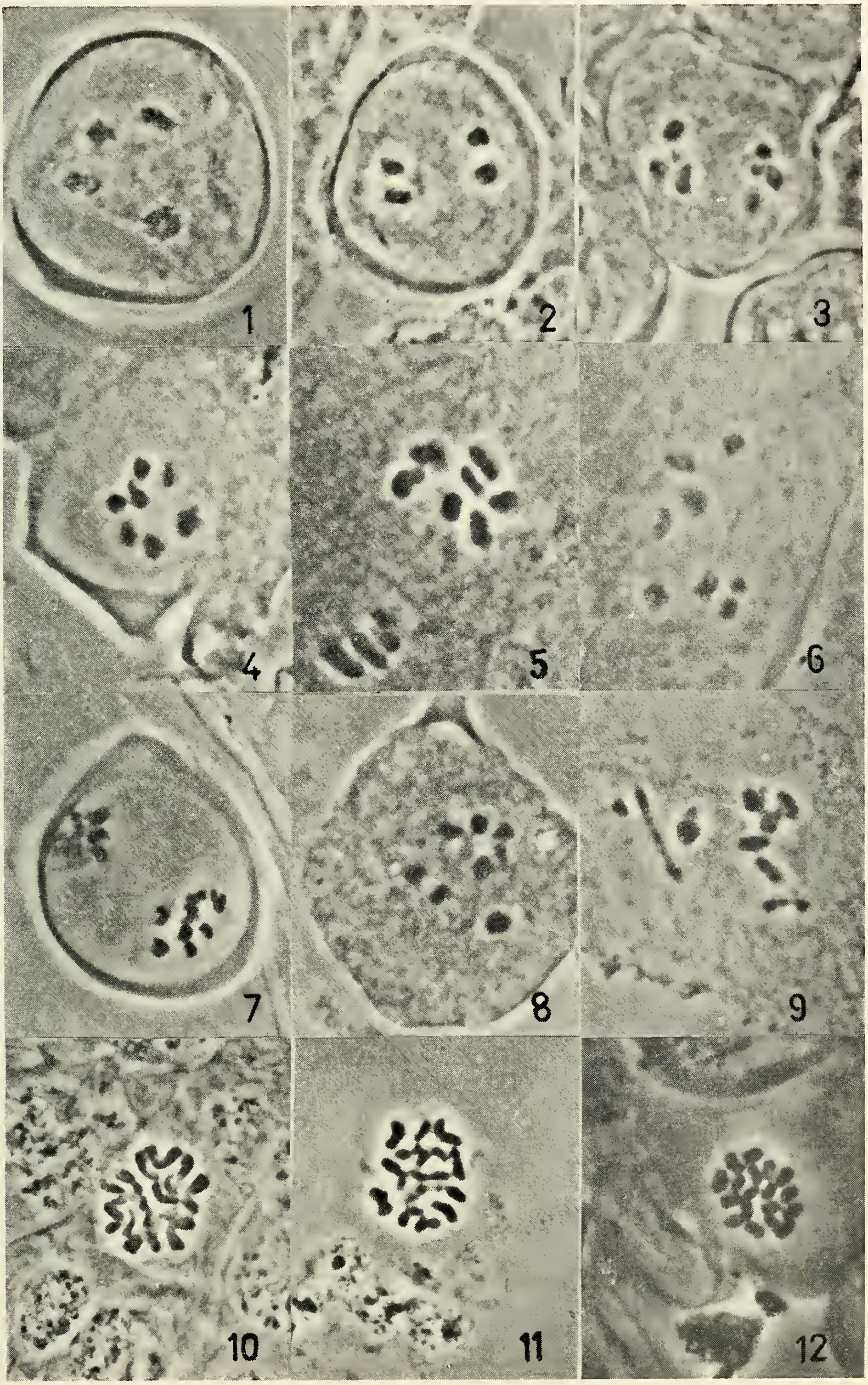
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EXPLANATION OF PLATE XVI

Representative species of *Pultenaea.*

1. *Pultenaea reticulata* P_I $n = 4$. 2. *P. reticulata* M_I $n = 4$. 3. *P. reticulata* M_{II} $n = 4$. 4. *P. boormanii* M_I $n = 7$. 5. *P. elliptica* M_{II} $n = 7$. 6. *P. fasciculata* P_I $n = 8$. 7. *P. microphylla* M_{II} $n = 8$. 8. *P. trinervis* M_I $n = 8$. 9. *P. vrolandii* M_I $n = 9$. 10. *P. euchila* mitosis $2n = 14$. 11. *P. canescens* mitosis $2n = 14$. 12. *P. acerosa* mitosis $2n = 18$.

APPENDIX

Chromosome numbers in the Papilionaceae with accession numbers and localities

Species	State	Locality	Coll. no.	Chromosome no.	
BOSSIAEEAE Benth. and Hook. f.					
Bossiaea aquifolium Benth.	W	Quindanning	638.7.3		18
	W	Karragullen	638.6.2		18
B. buxifolia A. Cunn.	N	Warrumbungle Ranges	628.10.1		18
	N	Goonoo Forest	628.17.6		18
	N	Varneys Range, 13 km E. Jindabyne	6211.1.4		18
B. disticha Lindl.	W	Deepdene	638.11.8		18
B. eriocarpa Benth.	W	Gingin to Mogumber	638.4.5		18
	W	8 km S.W. Northam	637.4.6		18
	W	Pinjarra	638.9.2		18
B. foliosa A. Cunn.	N	Goonoo Forest	619.10.6		18
	N	Kosciusko Rd	6211.2.6		18
B. heterophylla Vent.	N	National Park	635.2.2		18
	N	Hazelbrook	635.3.1		18
B. kiamensis Benth.	N	Belmore Falls	639.6.1		18
B. laidlawiana Tovey et Morris	W	Stewart Highway	638.12.6		18
B. lenticularis Sieber ex DC.	N	Colo Heights	627.1.9	9	
	N	Oakdale	628.20.7		18
B. linophylla R. Br.	W	Kojunup	638.8.4		18
B. obcordata (Vent.) Druce	N	5 km W. Penrith	628.21.7	9	18
	N	Faulconbridge	628.21.12		18
	N	Linden	619.1.5	9	
	N	Pennant Hills Reserve	618.1.4	9	
B. ornata (Lindl.) Benth.	W	Bannister	638.9.6		18
B. peduncularis Turcz.	W	21 km N. Southern Cross	637.4.2		18
B. preissii Meissn.	W	21 km W. Lake Grace	638.19.10		18
	W	Cape Riche Rd, Green Ranges	638.14.25		18
	W	29 km E. Gnowangerup	638.16.5		18
B. prostrata R. Br.	N	Coxs River, Jenolan	6310.8.13		18
B. pulchella Meissn.	W	51 km S.W. Northam	637.4.17		18

Species	State	Locality	Coll. no.	Chromosome no.	
B. rhombifolia Sieber ex DC. ssp. *rhombifolia*	Q	Glenmorgan	628.4.19		18
	N	8 km N. Sackville	627.1.4	9	
	N	Lower Portland Ferry	619.3.2	9	
B. rhombifolia ssp. *concolor* (Maid. et Betche) A. Lee	Q	Moonie Hwy, 85 km E. St George	628.5.4	9	
	Q	Moonie Hwy, Westmar	628.5.5		18
	N	Pilliga Scrub	628.9.1	9	
B. riparia A. Cunn. ..	N	Yarrangobilly	6211.3.5		18
B. scolopendria Sm.	Q	Glenmorgan	628.4.20		18
	N	Warrah	628.13.4		18
B. stephensonii F. Muell. ..	N	8 km S. Port Macquarie	628.15.4		18
	N	National Park	627.2.1		18
	N	5 km N. Heathcote	6110.4.2		18
B. walkeri F. Muell. ..	Q	Glenmorgan	628.4.1		18
Bossiaea sp.	N	Goonoo Forest	628.17.6		18
Goodia lotifolia Salisb. ..	W	18 km N. Ravensthorpe	638.19.1		16
Hovea chorizemifolia (Sweet) DC.	W	Quindanning	638.7.4		18
	W	Brunswick Junction	638.8.1		18
H. elliptica (Sm.) DC. ..	W	Metricul Siding	638.11.4		18
	W	Alexandra Bridge	638.12.1		18
H. heterophylla A. Cunn. ..	Q	Condamine Hwy to Meandarra	628.4.23		18
	Q	16 km N.W. Stanthorpe	628.6.7		18
	N	Gibraltar Range State Forest	628.2.7		18
H. linearis R.Br.	N	8 km S. Port Macquarie	628.15.6		18
	N	Colo Heights	627.1.1		18
	N	National Park	627.2.3		18
H. longifolia R.Br.	Q	Kogan	628.3.1		18
	Q	Glenmorgan	628.4.9		18
	Q	Moonie Hwy, Westmar	628.5.1		18
	Q	48 km N.W. Stanthorpe	628.6.1		18
	Q	Jollys Falls, Stanthorpe	628.6.15		18
	N	Yetman	628.8.6		18
	N	Warrumbungle Ranges	628.10.10		18
	N	Goonoo Forest	628.12.2		18
	N	Kosciusko Rd	6211.2.7		18
H. longipes Benth.	Q	Glenmorgan	628.4.2		18
H. pungens Benth.	W	South of New Norcia	637.5.14		18
H. stricta Meissn.	W	Mogumber	638.4.4		18
	W	Yanchep	638.5.4		18
H. trisperma Benth... ..	W	Bindoon	638.4.2		18
	W	East Bullsbrook Rd	637.5.5		18
	W	48 km S.W. Northam	637.4.16		18
	W	Brookton Hwy, Gleneagle State Forest	638.6.3		18
	W	Brunswick Junction	638.8.2		18
Platylobium formosum Sm. ..	N	Warrah	618.8.2		16
	N	Sunny Corner State Forest	6110.3.1		16
	N	Neville	6110.3.2		16
	N	Wentworth Falls	628.21.19		16
	N	Waterfall	6110.4.8	8	
	N	Garie, National Park	637.2.4		16
	N	Huskisson	639.5.10		16
Templetonia aculeata (F. Muell.) Benth.	W	79 km E. Jerramungup	638.16.18		16
T. retusa (Vent.) R.Br. ..	W	Bunbury	626.1.1		16
	S	Pt Lincoln, (St Andrews Tce)	649.2.2		16
T. sulcata (Meissn.) Benth.	W	61 km W. Coolgardie	637.3.2		16
	W	3 km N. Southern Cross	637.4.1		16
	W	Tambellup	638.15.10		16
INDIGOFEREAE Benth. and Hook.f.					
Indigofera australia Willd. ..	Q	Glenmorgan	628.4.22		16
	Q	16 km N.W. Stanthorpe	628.6.9		16

Species	State	Locality	Coll. no.	Chromosome no.	
Indigofera australia Willd.—*continued*	N	Pilliga Scrub	628.9.3		16
	N	8 km S. Pt Macquarie	628.15.6		16
	N	Wellington	628.18.1		16
	N	56 km E. Queanbeyan	639.4.5		16
	N	Kosciusko Rd	6211.2.3		16
I. australia var *signata* F. Muell.	N	Warrumbungle Ranges	628.10.6	8	16
	N	Wellington	628.18.2		16
	N	6 km S. Talbingo	6211.3.7		16
I. coronillifolia A. Cunn ..	N	Goonoo Forest	619.10.7	8	
COLUTEAE Benth. and Hook.f.					
Swainsona galegifolia R.Br.	Q	Glenmorgan	628.4.3	8	16
	N	Warrumbungle Ranges	628.10.9		32
	N	Dripstone	628.16.2		32
	N	Wellington	628.18.3		16
	N	Kanangara	6111.2.2		32
	N	Jenolan Caves	6212.1.1		16
TEPHROSIEAE Benth. and Hook.f.					
Tephrosia purpurea Pers. ..	N	Dripstone	628.16.3	8	16
GLYCINEAE Benth.					
Glycine clandestina Wendl.	N	Warrumbungle Ranges	628.10.7		40
	N	Cronulla	6111.1.1		20
	N	Oakleigh	619.5.1		40
Hardenbergia comptoniana Benth.	W	Yanchep	638.5.2		22
H. violacea (Schneev.) Stearn	Q	Glenmorgan	628.4.5		22
	N	Pt Macquarie	628.1.2		22
	N	Neville	6110.2.1	11	
	N	Vittoria	619.9.1		22
	N	Sunny Corner State Forest	6110.3.2		22
	N	Cronulla	618.9.1	11	
H. violacea " var. *rosea* " ..	S	Adelaide	625.1.4	11	22
Kennedia coccinea Vent. ..	W	Kelmscott	638.6.1		22
	W	Porongorup Ranges	638.13.6		22
	W	Chillingup, Green Ranges	638.14.24		22
K. eximia Lindl.	W	16 km E. Gnowangerup	638.16.1		22
K. nigricans Lindl. ..	W	32 km N. Perth	625.1.2	11	22
K. prostrata R.Br.	N	16 km S. Bodalla	6210.1.9		22
	W	Wanneroo	637.5.3		22
	W	8 km S.W. Northam	637.4.7		22
K. rubicunda Vent.	N	Colo River	618.8.1		22
	N	Pearl Beach	619.3.1		11
CAJANEAE Benth. and Hook.f.					
Rhynchosia minima DC. ..	Q	32 km S. Warwick	628.2.15		22
PODALYRIEAE Benth.					
Aotus ericoides (Vent.) G. Don.	N	Heathcote	618.3.2		16
	N	National Park	627.2.6	8	
	N	27 km N. Nerriga	639.11.14		16
	N	40 km S. Nowra	639.5.6		16
	N	16 km N. Moruya	6210.1.7		16
	N	Junction Hume Hwy and Snowy Mtn Hwy	6210.2.1		16
	S	16 km S. Kimba, Eyre Peninsula	649.4.1		16
	W	Yanchep	638.5.6		16
	W	29 km W. Albany	628.12.11		16
	W	Manypeaks	638.14.1		16
A. preissii Meissn.	W	Mogumber to Gingin	638.4.6		16
	W	39 km E. Ravensthorpe	638.18.1		16
A. subglauca Blakely et McKie	Q	Wyberba National Park	628.7.4		16
	N	Pilliga Scrub	628.9.2		16

Species	State	Locality	Coll. no.	Chromosome no.	
A. subglauca var. *filiformis* Blakely et McKie	Q	Moonie Hwy, 85 km E. St. George	628.5.6	8	16
Brachysema lanceolatum Meissn.	Q	Glenmorgan, from W.A.	628.4.14	8	
B. latifolium R.Br.	W	Chillingup to Keerjanup West Rd	638.14.27		16
B. praemorsum Meissn.	W	Kojunup	638.8.5		16
B. sericea (Sm.) Domin.	W	Denmark	638.12.9		16
Burtonia scabra R.Br.	W	Green Ranges	638.14.14		18
Chorizema aciculare (DC.) Gardn.	W	Bannister	638.7.1		32
	W	18 km E. Gnowangerup	638.16.3		16
C. cordatum Lindl.	W	Arthur River	638.8.3		16
	W	Pinjarra	638.9.3		16
C. cytisoides Turcz.	W	Albany to Mt Barker	638.13.2		16
	W	Cape Riche Rd, Green Ranges	638.14.20		16
C. dicksonii Grah.	W	47 km S.W. Northam	637.4.15		16
C. ericifolium Meissn.	W	252 km N. Perth	638.1.2		16
C. glycinifolium (Sm.) Druce	W	16 km W. Albany	638.12.17		16
	W	19 km E. Ongerup	638.16.9		16
C. ilicifolium Labill.	W	Collie to Arthur River	638.8.3		16
	W	Pinjarra to Boddington	638.9.3		16
C. nervosum T. Moore	W	56 km E. Jerramungup	638.16.16		16
C. reticulatum Meissn.	W	Albany to Mt Barker	638.13.1		16
C. rhombeum R.Br.	W	Cape Riche Rd, Green Ranges	638.14.23		16
Cupulanthus bracteolosus (F. Muell.) Hutch.	W	South Stirlings	638.14.29		16
Daviesia acicularis Sm.	Q	Moonie Hwy, Westmar	628.5.2	9	
	Q	Jollys Falls, Stanthorpe	628.12.11		18
	N	Coonabarrabran	628.11.3		18
	N	Goonoo Forest	628.17.10		18
D. alata Sm.	N	National Park	629.2.1		18
D. brevifolia Lindl.	S	Fishery Bay Rd, S. Pt Lincoln	649.2.7		18
D. corymbosa Sm.	N	Wentworth Falls	628.21.20	9	
	N	Waterfall	6110.4.7		18
	N	Heathcote	618.4.7	9	
D. daphnoides Meissn.	W	18 km W. Lake Grace	638.19.9		18
D. divaricata Benth.	W	270 km N. Perth	638.1.4		18
	W	Bannister	638.7.2	9	
D. flexuosa Benth.	W	Stewart Hwy	638.12.4		18
D. genistifolia A. Cunn. ex Benth.	Q	16 km S. Warwick	628.2.14		18
	Q	Moonie Hwy, Westmar	628.5.3		18
	N	Pilliga Scrub	628.9.3	9	
	N	Warrumbungle Ranges	628.10.13		18
	N	Goonoo Forest	628.17.11	9	
	N	Buladelah State Forest	628.14.6		18
	S	Mt Shannon, 63 km S. Kimba	649.4.4		18
D. grahamii Ewart and White	W	18 km N. Bruce Rock	639.1.6		18
D. horrida Meissn.	W	Bullsbrook	638.4.8	9	
D. incrassata Sm.	W	Three Springs	638.2.3		18
	W	32 km S.W. Northam	637.4.12		18
	W	Mumballup	638.8.6		18
D. juncea Sm.	W	East Bullsbrook Rd	637.5.6		18
	W	37 km W. Wyalkatchem	637.4.5		18
D. latifolia R. Br.	Q	Wyberba National Park	628.7.3		18
	N	24 km E. Glen Innes	628.2.4		18
	N	Warrumbungle Ranges	628.10.12		18
	N	Vittoria	619.9.2	9	
	N	Waterfall	6110.4.7		18
D. mimosoides R.Br.	N	16 km S. Canberra	6210.2.6		18
	N	Kosciusko Rd	6211.2.4	9	
D. nematophylla (F. Muell.) Benth.	W	16 km N. Bruce Rock	639.1.7		18

Species	State	Locality	Coll. no.	Chromosome no.	
D. nudiflora Meissn.	W	Yanchep	638.5.3		18
	W	Wanneroo	637.5.1		18
D. pachyphylla F. Muell.	W	51 km E. Jerramungup	638.16.15		18
D. pectinata Lindl.	W	13 km S.W. Northam	637.4.8		18
	S	Fishery Bay Rd, S. Pt Lincoln	649.2.6		18
D. pubigera A. Cunn. ex Benth	N	Warrumbungle Ranges	628.10.1		18
	N	Goonoo Forest	628.17.7	9	
D. reversifolia F. Muell.	W	39 km E. Jerramungup	638.16.11		18
D. rhombifolia Meissn.	W	40 km S.W. Northam	637.4.13		18
	W	Gleneagle State Forest, Brookton Hwy	638.6.5		18
D. squarrosa Sm.	N	Gibraltar Range State Forest	628.2.12	9	18
	N	5 km W. Penrith	628.21.5		18
	N	16 km N. Batemans Bay	639.5.1		18
D. squarrosa var. *villifera* (A.cunn. ex Benth.) Benth.	Q	Helidon Hills	638.20.5		18
	N	Yetman	628.8.7	9	
D. striata Turcz.	W	Dandarragan	638.3.6		18
D. teretifolia Benth.	W	51 km E. Jerramungup	638.16.14		18
D. trigonophylla Meissn.	W	Green Ranges	638.14.19		18
D. ulicifolia Andr.	Q	Glenmorgan	628.4.21		18
	N	Yetman	628.8.1		18
	N	Goonoo Forest	619.10.10	9	
	N	Buladelah State Forest	628.14.7		18
	N	Lower Portland Ferry	619.3.7	9	
	N	7 km W. Kurrajong Heights	619.2.1		18
	N	Liverpool	619.4.3		18
	N	Kosciusko Road	6211.2.5		18
D. umbellulata Sm.	N	32 km S. Pt Macquarie	628.15.2	9	
D. uniflora D. A. Herbert	W	23 km W. Lake Grace	638.19.11		18
D. virgata A. Cunn. ex Hook.	N	Kings Plain	6110.2.4	9	
	N	8 km N. Goulburn	6210.3.2		18
Dillwynia acicularis Sieber ex DC.	N	Calga	6310.2.4		14
D. brunioides Meissn.	N	Kings Tableland	639.7.7		14
	N	Currarong Rd, 8 km S. Nowra	639.5.15		14
	N	11 km N. Nerriga	639.11.13	7	
	N	31 km N. Nerriga	639.11.15		14
D. cinerascens R.Br.	W	37 km S. New Norcia	637.5.8		14
	W	Brookton Hwy	638.6.10		14
	W	Dunsborough	638.11.2		14
D. dillwynioides Meissn.	W	Brockman Hwy	638.12.3		14
D. floribunda Sm.	Q	Pottsville	638.20.1		14
	Q	Currimundi	638.20.6		14
	N	Coonabarrabran to Mendooran	628.11.2	14	
	N	Wilberforce	627.1.11		14
	N	Colo	627.1.10		14
	N	Kings Tableland	639.10.6		14
	N	Woodford	639.10.3		14
	N	Warrah	618.8.6	14	28
	N	Warrah	628.13.5	14	14, 28
	N	Warrah	637.1.1	14	28
	N	Woronora Dam Rd	637.2.3		14
	N	National Park	627.2.5	7	14
	N	National Park	635.2.6	7	14
D. floribunda var. *teretifolia* (DC.) Blakely	N	Woy Woy	628.13.1		14
D. glaberrima Sm.	N	La Perouse	6110.6.4	7	
	N	Burrill Lakes	639.5.5		14
	V	Grampian Ranges	6310.5.15		14
D. hispida Lindl.	V	Kiata	6310.5.5		14
D. juniperina Lodd.	Q	48 km N.W. Stanthorpe on Inglewood Rd	628.6.2	7	14
	N	Mendooran	628.11.7		14
	N	Goonoo Forest	618.6.3		14

Species	State	Locality	Coll. no.	Chromosome no.	
D. juniperina Lodd.—*continued*	N	Goonoo Forest	628.12.3		14
	N	Lower Portland Ferry	619.3.5	7	
	N	14 km E. Penrith	619.1.2	7	
	N	Liverpool	619.4.2	7	
	N	5 km E. Queanbeyan	639.4.1		14
D. parvifolia R.Br.	N	2 km S. Batemans Bay	6210.1.5	7	14
	N	19 km S. Batemans Bay	639.5.3		14
	N	13 km N. Moruya	6210.1.8	7	14
D. parvifolia var. *trichopoda* Blakely .. .. .. Blakely	Q	Gurulmundi transplant to Glenmorgan	628.4.13	7	14
	N	Buladelah	628.14.2	7	
	N	1 km W. Morisset	639.8.7		28
	N	1 km W. Glenbrook	6110.9.4	14	
	N	Oakdale (prostrate form)	619.8.1	7	
	N	Oakdale (erect form)	628.20.2	7	
	N	Falls Creek turnoff to Huskisson	6210.1.2	14	28
D. peduncularis Benth. ..	Q	Stanthorpe	638.20.9		14
	N	Wollumbi	6310.2.3		14
	N	1 km E. Linden	6110.9.5		14
	N	3 km W. Faulconbridge	628.21.13		14
	N	De Burghs Bridge, Pymble	629.3.1		14
	N	29 km W. Batemans Bay	639.4.7		14
	S	8 km N.E. Warrow, Eyre Peninsula	649.4.5		14
D. phylicoides A. Cunn. ..	Q	Wyberba National Park	628.7.2	14	
	N	Gibraltar Range State Forest	628.2.11		14
	N	Warrumbungle Ranges	628.10.3,8,14	14	28
	N	Mullion Creek, 19 km N. Orange	628.19.3		28
	N	3 km E. Kings Plain	6110.2.5	7	
	N	5 km W. Bell	6310.8.4		14
	N	Jenolan Rd	6310.8.11		14
	N	2 km W. Hartley Vale	6310.4.5	7	
	N	Black Mountain, Canberra	639.3.4		28
D. prostrata, Blakely ..	N	Dry Plains, S. Adaminaby	6211.3.2		28
	N	27 km S. Talbingo	6211.3.4	14	
D. ramosissima Benth. ..	N	7 km N. Nerriga, Pigeon House Range	639.11.12		14
	N	Currarong Rd, 8 km S. Nowra	639.5.12		14
D. retorta (Wendl.) Druce ..	N	Warrah	618.8.11		14
	N	Kuring-gai	618.2.1	7	
	N	Pennant Hills Reserve	618.1.2	7	
	N	National Park near Audley	635.2.1,7		14
	N	National Park near Waterfall	6110.4.3		28
	N	La Perouse	6110.6.3		28
	N	Woronora Dam Rd	637.2.1		14
D. rudis Sieber ex DC. ..	N	Wollumbi	6310.2.1		14
	N	Bells Line of Rd	639.7.8		14
D. sericea A. Cunn.	N	45 km N. Dubbo to Mendooran	628.17.2		14
	N	Dubbo Arboretum	628.17.14		14
	N	Mullion Creek, 19 km N. Orange	628.19.2		14
	N	5 km E. Kings Plain	6110.2.3	7	
	N	Warragamba Dam	6210.4.2		14
	N	Monaro Hwy, 16 km S. Canberra	6210.2.4	7	14
	N	7 km E. Queanbeyan	639.4.3		14
	N	14 km E. Bungendore	639.11.2		14
	N	40 km W. Yass	639.3.2		14
	N	Cooma	6211.3.1	7	
	V	Grampians Ranges	6310.5.7		14
D. stipulifera Blakely ..	N	Dargans Creek, Clarence	6310.8.7		21
D. tenuifolia Sieber ex DC.	N	Bells Line of Rd, Kurrajong turnoff	6110.9.13	7	
	N	Linden to Woodford	639.7.5		14
D. uncinata (Turcz.) Gardn.	W	40 km W. Coolgardie	637.3.1		14
	W	24 km N. Ravensthorpe	638.19.3		14

Species	State	Locality	Coll. no.	Chromosome no.	
D. uncinata (Turcz.) Gardn.—*continued*	S	3 km N. Arno Bay turnoff, Eyre Peninsula	649.1.2		14
Euchilopsis linearis (Benth.) F. Muell.	W	East Bullsbrook Rd	637.5.7	7	
	W	3 km W. Albany	638.12.16		14
Eutaxia densifolia Turcz. ..	W	Green Ranges	638.14.12		16
	W	3 km E. Ongerup	638.16.8		32
E. epacridoides Meissn. ..	W	Brockman Hwy.	638.12.2		16
E. microphylla (R.Br.) Gardn.	V	Kiata	6310.5.4		32
	W	Bullfinch to Southern Cross	639.1.1		16
	S	3 km N. Arno Bay turnoff, Eyre Peninsula	649.1.1		16
	S	14 km S. Arno Bay turnoff, Eyre Peninsula	649.1.4		16
E. microphylla var. *diffusa* (F. Muell.) A. B. Court ..	S	St Andrews Tce to Sandspits, Pt Lincoln	649.2.3	8	
	S	Brownlaw Rd, 11 km from Kingscote to American River, Kangaroo Is.	649.5.1		16
	S	7 km S. Nhill to Winniam	649.6.4		16
E. parvifolia Benth. ..	W	58 km E. Jerramungup	638.16.17		16
E. virgata Benth.	W	42 km N. Bullfinch	639.1.4		16
	W	Capel	638.10.4		16
	W	29 km W. Albany	638.12.10		16
Gastrolobium bennettsianum Gardn.	W	11 km E. Wyalkatchem	639.1.10		16
G. bidens Benth.	W	335 km N. Perth	638.1.5		16
	W	252 km N. Perth	638.1.1		16
G. bilobum R.Br.	W	Albany	638.12.13	8	16
G. calycinum Benth. ..	W	130 km N. Perth	637.5.9		16
	W	Boddington	638.9.7		16
G. crassifolium Benth. ..	W	24 km E. Gnowangerup	638.16.4		16
G. hamulosum Meissn. ..	W	24 km W. Lake Grace	638.19.13		16
G. hookeri Meissn.	W	Brookton Hwy	638.6.8		16
	W	Pingelly	638.6.12		16
G. microcarpum Meissn. ..	W	16 km S.W. Northam	637.4.10		16
G. obovatum Benth.	W	29 km W. Wyalkatchem	637.4.4		16
G. parvifolium Benth. ..	W	11 km E. Yoting	639.1.9		16
	W	Brookton Hwy	638.6.11		16
G. polystachyum Meissn. ..	W	130 km N. Perth	637.5.10		16
G. pulchellum Turcz. ..	W	16 km S.W. Northam	637.4.11		16
G. reticulatum (Meissn.) Benth.	W	18 km E. Gnowangerup	638.15.2		16
G. spathulatum Benth. ..	W	S. New Norcia	637.5.15		16
G. spinosum Benth.	W	7 km N. Gingin	638.4.7		16
	W	13 km E. Yoting	639.1.8		16
	W	Stirling Ranges	638.15.3		16
	W	Ravensthorpe to Hopetoun	638.17.5		16
G. stowardii S. Moore ..	W	Eneabba	638.2.2		16
G. trilobium Benth.	Q	Glenmorgan	628.4.6		16
G. velutinum Lindl.	W	Stirling Ranges to Cranbrook	638.15.4		16
	W	Mt Barker to Porongorup Ranges	638.13.4		16
	W	66 km N. Ravensthorpe	638.19.6		16
G. villosum Benth.	W	South of New Norcia	637.5.16		16
	W	Brookton Hwy, Gleneagle State Forest	638.6.4		16
Gompholobium burtonioides Meissn.	W	Cape Riche Rd, Green Ranges	638.14.10		18
G. glabratum Sieber ex DC.. .	N	2 km E. Linden	619.1.4		18
	N	Waterfall	6110.4.13		18
G. grandiflorum Sm. ..	N	Warrah	618.8.4	9	
	N	Adelina Falls	6110.9.9		18
	N	Colo Heights	627.1.5		18

Species	State	Locality	Coll. no.	Chromosome no.	
G. huegelii Benth.	N	Kanangra	6111.2.1		18
	N	Mt Victoria Pass	6310.8.10		18
	N	Clarence	6310.8.8		18
G. knightianum Lindl. ..	W	Yanchep	638.5.5		18
	W	Green Ranges	638.14.16		18
	W	Ravensthorpe to Hopetoun	638.17.12		18
G. latifolium Sm.	N	Warrah	618.8.5	9	18
	N	Colo Heights	627.1.8		18
	N	Wentworth Falls	628.21.21	9	
G. marginatum R.Br. ..	W	Chester Pass, Stirling Ranges	638.15.2		18
G. minus Sm.	N	47 km N. Braidwood on Nerriga Rd	639.11.11		18
G. polymorphum R.Br. ..	W	Green Ranges	638.14.15		18
G. tomentosum Labill. ..	W	31 km E. Gnowangerup	638.16.6		18
G. uncinatum A. Cunn. ex Benth.	N	Mt Victoria Pass	6310.8.9		18
G. venustum R.Br.	W	Green Ranges	638.14.13		18
G. viscidulum Meissn. ..	W	Ravensthorpe to Hopetoun	638.17.4		18
Isotropis cuneifolia (Sm.) Domin.	W	373 km N. Perth	638.1.7		16
	W	246 km N. Perth	638.1.3		16
	W	Mandurah	638.10.12		32
	W	Green Ranges	638.14.17		16
Jacksonia cupulifera Meissn.	W	Moora	638.3.1		18
J. furcellata (Bonpl.) DC. ..	W	Yanchep	638.5.1		18
J. horrida DC.	W	Witchcliffe turnoff	638.11.5		18
J. racemosa Meissn.	W	47 km E. Ravensthorpe	638.18.3		18
J. scoparia R.Br.	Q	Glenmorgan	628.4.12	9	18
	Q	39 km N.W. Stanthorpe	628.6.6		18
	N	Dooralong Valley	639.8.4		18
	N	1 km E. Glenbrook	6110.9.2		18
J. sternbergiana Hueg. ..	W	Dandarragan	637.3.2		18
	W	Wanneroo	638.5.2		18
J. ulicina Meissn.	W	369 km N. Perth	638.1.6		18
Latrobea hirtella (Turcz.) Benth.	W	Mt Barker	638.13.3		14
	W	Green Ranges	638.14.18		14
Leptosema aphyllum Hook.	W	Three Springs	638.2.1		16
Mirbelia baueri (Benth.) J. Thompson	N	31 km N. Nerriga	639.11.16		16
M. depressa E. Pritzel ..	W	42 km N. Bullfinch	639.1.3		16
	W	Ravensthorpe to Hopetoun	638.17.1		16
M. floribunda Benth. ..	W	Dandarragan	638.3.5		16
	W	145 km N. Perth	637.5.12		16
M. ovata Meissn.	W	Stirling Ranges to Cranbrook	638.15.7		16
	W	Tambellup	638.15.8		16
	W	Gnowangerup	638.15.11		16
M. oxylobioides F. Muell. ..	N	Varneys Range, 13 km E. Jindabyne	6211.1.2	8	
	N	Kosciusko Road	6211.2.1	8	
M. platylobioides (DC.) J. Thompson	N	Kings Tableland	628.21.16		16
	N	Wallerawang	6110.3.3		16
	N	77 km E. Queanbeyan	639.4.6		16
M. pungens A. Cunn. ex G. Don.	Q	Kogan	628.3.4		16
	Q	Glenmorgan	628.4.8		16
	Q	16 km N.W. Stanthorpe	628.6.8		16
	N	Dubbo Arboretum	628.12.7	8	
	N	Goonoo Forest	628.17.9		16
M. rubiifolia (Andr.) G. Don.	N	32 km S. Pt Macquarie	628.15.1		16
	N	Kuring-gai Chase	6110.5.2		16
	N	5 km W. Penrith	628.21.2		16
	N	Waterfall	6110.4.9		16
M. speciosa Sieber ex DC. ..	Q	32 km S. Warwick	628.2.10		16
	N	Gibraltar Range State Forest	628.2.8		16

Species	State	Locality	Coll. no.	Chromosome no.	
M. spinosa Benth.	W	Bullfinch	639.1.2		16
	W	135 km N. Perth	637.5.11	8	
M. trichocalyx Domin. ..	W	87 km W. Coolgardie	637.3.3		16
Nemcia axillare Meissn. ..	W	Dandarragan	638.3.4		16
N. capitatum Benth. ..	W	Mogumber	638.4.3		16
	W	East Bullsbrook Road	637.5.4		16
	W	47 km S.W. Northam	637.4.14		16
	W	Brookton Hwy, Gleneagle State Forest	638.6.6		16
N. coriaceum (Sm.) Domin.. .	W	Cheyne Bay	638.14.6		16
N. cuneatum Benth. ..	W	Pinjarra	638.9.1		16
	W	Bannister	638.9.9		16
N. drummondii S. Moore ..	W	Boddington	638.9.8		16
	W	Cheyne Bay	638.14.3		16
	W	Cape Riche Rd, Green Ranges	638.14.11		16
N. melanocaule E. Pritzel ..	W	Stirling Ranges to Cranbrook	638.15.5		16
N. reticulatum Meissn. ..	W	Safety Bay	638.10.1		16
	W	Moora to Dandarragan	638.3.3		16
Oxylobium aciculiferum (F. Muell.) Benth.	N	Dooralong Valley	639.8.5		16
O. alpestre F. Muell. ..	N	5 km S. Kiandra	6211.3.3		16
O. arborescens Ait.f. ..	N	14 km N. Marulan	6310.6.3		16
O. atropurpureum Turcz. ..	W	Brookton Hwy, Gleneagle State Forest	638.6.7		16
O. cordifolium Andr. ..	N	La Perouse	6110.6.2	8	
O. ellipticum (Labill.) R.Br.	N	Brindabella Ranges	639.11.17		16
	N	63 km S. Canberra	6210.2.2	8	16
O. ilicifolium (Andr.) Domin.	N	Wauchope	628.1.3		16
	N	Tea Gardens	618.10.1	8	
	N	Colo Heights	627.1.2		16
	N	Kurrajong	627.1.3	8	
	N	5 km W. Penrith	628.21.4	8	
	N	Oakdale	628.20.3	8	
	N	Batemans Bay	6210.1.6	8	
O. microphyllum Benth. ..	W	18 km N. Ravensthorpe	638.19.15		16
O. parviflorum Benth. ..	Q	Glenmorgan	628.4.7	8	
	W	60 km W. Southern Cross	637.4.3		16
	W	Brookton Hwy	638.6.9		16
	W	Chillingup to Keerjanup West	638.14.26		16
O. procumbens F. Muell. ..	N	Varneys Range, 13 km E. Jindabyne	6211.1.3	8	
O. pulteneae DC.	N	Calga	6310.2.5		16
O. racemosum Turcz. ..	W	18 km N. Ravensthorpe	638.19.2		16
O. robustum J. Thompson ..	N	Harrington	6311.1.2		16
O. scandens (Sm.) Benth. ..	N	Batemans Bay	6210.1.4		16
O. spectabile Endl.	W	48 km E. Jerramungup	638.16.13		16
O. tetragonophyllum E. Pritzel	W	35 km E. Jerramungup	638.16.10		16
Oxylobium sp.	W	Gleneagle State Forest	638.6.7		16
Phyllota humifusa Benth. ..	N	13 km W. Mittagong	6210.4.1	7	14
P. phylicoides (Sieber ex DC.) Benth.	N	Warrah	628.13.6		14
	N	Kuring-gai	618.2.5	7	
	N	Windsor	627.1.12		14
	N	Kings Tableland	628.21.17		14
	N	Wentworth Falls	628.9.8		14
	N	National Park	627.2.2	7	
	N	32 km S. Nowra	639.5.7		14
Pultenaea acerosa R.Br. ..	S	Mt Lofty Railway Station	639.2.6	9	18
	S	Mt Lofty Ranges	6312.3.1		18
	S	Foreshore S. Port Lincoln	649.2.1		18
	S	Fishery Bay Rd, S. Pt Lincoln	649.2.8		18
	S	Flinders Monument Rd, S. Pt Lincoln	649.2.10		18
	S	Penneshaw Rd, 19 km from Kingscote, Kangaroo Is.	649.5.3		18

Species	State	Locality	Coll. no.	Chromosome no.	
P. acerosa var. *acicularis* H. B. Williamson ..	S	Vivonne Bay, Kangaroo Is.	649.5.13		18
P. adunca Turcz.	W	Ravensthorpe to Hopetoun	638.17.3		14
P. altissima F. Muell. ex Benth.	N	Corang River, 42 km N. Braidwood	639.11.10	7	
P. andrewsii C. A. Gardn. ..	W	53 km N. Ravensthorpe	638.19.4		14
P. angustifolia Benth. ..	V	Silverband Rd, Grampians Ranges	6310.5.8		18
	V	N. Halls Gap, Grampians Ranges	649.7.2		18
P. aristata Sieber ex DC. ..	N	Mullion Creek, 19 km N. Orange	628.19.1		16
	N	Darke Forest turnoff on Princes Hwy	639.6.6		16
P. benthamii F. Muell. ..	V	3 km up Mt William Rd, Grampians Ranges	649.7.12		16
P. blakelyi J. Thompson ..	N	Garie Beach Rd, National Park	637.2.2		16
	N	1 km before Belmore Falls	639.6.4		16
	N	Termeil State Forest, 24 km S. Milton	639.5.4		16
P. boormanii Williamson ..	N	Sutton, 19 km N. Canberra	6310.6.1	7	
	N	18 km E. end of Sturt Hwy	639.3.1	7	14
P. calycina (Turcz.) Benth.	W	Keerjanup West Rd, Green Ranges	638.14.28	8	16
P. campbelli Maiden et Betche	N	Bucketty, convicts' drinking pump	648.1.3	7	14
P. canaliculata F. Muell. ..	V	Portland	6310.5.19		16
P. canaliculata var. *latifolia* Williamson	S	8 km from Seal Bay turnoff, Kangaroo Is.	649.5.6	8	
	S	" Brookland Park ", Kangaroo Is.	649.5.10		16
P. canescens A. Cunn. ..	N	5 km E. Bell	6310.8.3		14
	N	Head of Dargans Creek, Clarence	6310.8.5		14
	N	3 km S. Marulan	6310.6.2	7	14
	N	2 km N. Goulburn	6210.3.1	7	14
P. capitellata Sieber ex DC.	N	Mt. Werong, S. Oberon	6411.3.1		16
	N	The Crater, below Mt Wilson	6411.1.1		16
P. costata Williamson ..	V	2 km S. Zumsteins, Grampians Ranges	649.7.1		18
	V	7 km N.W. Halls Gap, Grampians Ranges	649.7.4		18
	V	Silverband Rd, Grampians Ranges	649.7.8		18
P. cunninghamii (Benth.) Williamson	Q	Glenmorgan, from Helidon	628.4.17	7	
	N	Wollumbi	6310.2.2		14
	N	7 km S. Talbingo	6211.3.6	7	
P. d'altonii Williamson ..	V	Black Ranges Rd	649.7.16	6	12
P. daphnoides Wendl. ..	N	Woy Woy	618.8.8		16
	N	Moonie Moonie	639.8.3		16
	N	16 km S. Bodalla	6210.1.11		16
	S	3 km before Mylor, Mt Lofty Ranges	639.2.1		16
	V	7 km S.E. Daylesford on Trentham Rd	649.9.2		16
P. dasyphylla (Turcz.) C. A. Gardn.	W	42 km E. Newdegate	638.19.8		14
P. densifolia F. Muell. ..	S	2 km on Vivonne Bay Rd, Kangaroo Is.	649.5.5		16
P. dentata Labill.	V	Grampians Ranges	6310.5.17	16	32
P. divaricata Williamson ..	N	Sublime Point Rd, Blue Mountains	6310.4.2		16
	N	Head of Dargan's Creek, Clarence	6310.8.6		16
P. echinula Sieber ex DC. ..	Q	Glenmorgan, from Stanthorpe	628.4.16		16

Species	State	Locality	Coll. no.	Chromosome no.	
P. elliptica Sm.	N	5 km N. Morrisset	639.8.9		14
	N	Linden	639.10.2	7	
	N	Glenbrook	649.10.1		14
	N	3 km S. Audley, National Park	6110.8.1		14
	N	3 km S. Audley, National Park	635.2.3		14
	N	Bundeena Rd	635.2.11		14
	N	Jervis Bay	634.1.2		14
P. empetrifolia Meissn.	W	34 km E. Gnowangerup	638.16.7	7	14
	W	Chester Pass, Stirling Ranges	638.15.1	7	14
P. ericifolia Benth.	W	89 km E. Jerramungup	638.16.19		14
	W	55 km N. Ravensthorpe	638.19.5		14
P. euchila DC.	N	22 km W. Grafton on Glen Innes Rd	6410.1.3		14
	N	Freemans Waterholes, N. Toronto	639.8.14		14
	N	Freemans Waterholes, N. Toronto	648.1.2		14
P. fasciculata Benth.	N	Waste Point, Snowy Mountains	631.1.1	8	
P. ferruginea Rudge	N	Wisemans Ferry	6110.7.1	7	
	N	Lapstone Hill Reserve	648.4.2	7	
P. ferruginea var. *deanei* (R. T. Baker) Williamson	N	N. Berowra	639.8.1		14
	N	1 km S. northern exit of new Gosford Hwy	648.3.4	7	14
	N	Warrah	623.1.1		14
P. flexilis Sm.	Q	Helidon Hills	638.20.3		16
	N	Crows Nest	638.20.6		16
	N	Mt Wilson	6310.4.7		16
	N	Tinda Creek, Colo Heights	648.1.1		16
	N	Liverpool	619.4.1		16
P. foliolosa A. Cunn. ex Benth.	Q	48 km N.W. Stanthorpe, Inglewood Rd	628.6.4		14
	N	Yetman	628.8.3		14
	N	Coonabarrabran	628.11.6		14
	N	Goonoo Forest	619.10.8		14
	N	Dubbo Arboretum	628.17.12		14
P. georgei (Hensl.) Gardn.	W	18 km N. Bruce Rock	639.1.5	7	
P. glabra Benth.	N	Lone Pine Park, Leura	639.6.3		16
	N	Pool of Siloam, Leura	639.10.9		16
	N	Boddington Hill	639.7.6		16
	N	Wentworth Falls	648.4.3		16
	N	Adelina Falls	628.21.15		16
P. graveolens Tate	S	Mt Lofty Ranges	6310.3.2	8	16
	S	Ashton	6310.3.6	8	
P. gunnii Benth.	V	Trentham East to Bullengarook	649.9.3		14
P. hartmannii F. Muell.	Q	Wyberba National Park	628.7.6	8	16
	Q	39 km N.W. Stanthorpe, Inglewood Rd	628.6.5		16
	Q	Jollys Falls, N. Stanthorpe	628.6.13		16
	N	Gibraltar Ranges, 68 km E. Glen Innes	6410.1.2		16
P. hibbertioides Hook.f.	V	Mt Difficult Rd, Grampians Ranges	649.7.6		18
	V	Victoria Valley Rd, Grampians Ranges	649.7.9	9	
P. hispidula R.Br. ex Benth.	N	St Ives	6310.1.1		14
	N	Frenchs Forest	6310.1.2		14
	N	Loftus	648.2.2		14
P. humilis Benth.	V	North Grampians Ranges	639.9.2		14
	V	Wonderland, Grampians Ranges	649.7.5		14
	V	Black Ranges Rd	649.7.17		14
	V	Footsteppes of Mt Sturgeon, 7 km N. Dunkeld	6310.5.13		14

Species	State	Locality	Coll. no.	Chromosome no.	
P. humilis Benth.—*continued*	V	Footsteppes of Mt Sturgeon, 7 km N. Dunkeld	649.7.14	7	14
P. humilis var. *glabrescens* Williamson	V	Black Ranges	6310.5.18		14
P. incurvata A. Cunn. ..	N	Valley of the Waters, Blue Mountains	628.21.18		16
	N	Lone Pine Park, Leura	639.10.8		16
P. involucrata Benth. ..	S	Mylor, Mt Lofty Ranges	6310.3.3		16
P. juniperina var. *juniperina* Labill.	V	Mt Difficult Rd, Grampians Ranges	649.7.7		18
P. juniperina var. *planifolia* Williamson	N	2 km above Sawpit Creek, Kosciusko Rd	6211.2.8	9	18, 27
	N	Sawpit Creek Track, 2–3 km from Kosciusko Rd	6211.2.9		18, 27
	N	Two Sticks Rd, Brindabella Ranges	6310.7.1,2	9	27
P. largiflorens var. *latifolia* Williamson	S	Belair Hill, Mt Lofty Ranges	639.2.7		16
P. laxiflora Benth.	S	Upper Sturt Rd, 5 km S.W. Mt Lofty	6312.1.1		16
	V	2 km N.E. Lawloit	649.6.3		16
	V	Lowan Sanctuary, Kiata	649.6.5		16
	V	10 km S.W. Stawell	649.7.11		16
P. laxiflora var. *pilosa* Williamson	V	Kiata	6310.5.3		16
P. linophylla Shrad. ..	N	Eraring	639.8.10		32
	N	Lawson	639.10.4		16
	N	16 km N. Batemans Bay	639.5.2		16
P. lycopodioides (S. Moore) C. A. Gardn.	W	116 km W. Coolgardie	637.3.4	7	14
P. microphylla Sieber ex DC.	Q	39 km N.W. Stanthorpe, Inglewood Rd	628.6.5		16
	N	13 km N. Armidale	628.1.5	8	
	N	Walcha	628.1.4		16
	N	S. Coonabarrabran on Mendooran Rd	628.11.4	8	16
	N	Goonoo Forest	628.17.3, 4, 5	8	16
	N	Dubbo State Forest	628.17.13		16
	N	Dubbo Arboretum	628.12.6		16
	N	2 km E. Bell	6310.4.6		16
	N	19 km E. Penrith	628.21.1	8	16
	N	Rooty Hill	639.7.1		16
	N	14–19 km N. Braidwood on Nerriga Rd	639.11.7, 9		16
	N	5 km E. Queanbeyan	639.4.2		16
P. microphylla var. *cinerascens* (Maiden et Betche) Williamson	Q	48 km N.W. Stanthorpe, Inglewood Rd	628.6.3	8	
	N	Yetman	628.8.5		16
	N	Pilliga Scrub	628.9.7		16
	N	Warrumbungle Ranges	628.10.2		16
	N	S. Coonabarrabran on Mendooran Rd	628.11.1		16
P. mollis Lindl.	V	Footsteppes Mt Sturgeon, 7 km N. Dunkeld	649.7.15		18
P. mucronata F. Muell. ..	N	Junction of Blackheath and Shipley Rds	6310.8.14	8	16
P. muelleri Benth. var. *reflexifolia* J. H. Willis ..	V	5 km S.E. Daylesford on Trentham Rd	649.9.1		16, 32
P. myrtoides A. Cunn. ..	N	Karuah	649.10.2		16

Species	State	Locality	Coll. no.	Chromosome no.	
P. neurocalyx Turcz. ..	W	Daniels Rd, Ravensthorpe to Hopetoun	638.17.7		14
	W	46 km E. Ravensthorpe	638.18.2		14
P. obcordata (R.Br.) Benth.	W	Ravensthorpe to Hopetoun	638.17.6	9	
	W	11 km N. Esperance	638.18.4		18
P. obovata Benth.	Q	Mudjimbah	638.20.8	7	
P. paleacea Willd.	N	Eraring, 5 km N. Morisset	639.8.11		16
	N	Stockyard Creek near Rathmines	639.8.3		16
	N	Swansea	628.1.1		16
P. paleacea var. *robusta* Williamson	Q	Mudjimbah	638.20.7	8	
P. parviflora Sieber ex DC.	N	St Mary's	639.7.2		14
	N	St Mary's	648.4.1		14
P. patellifolia Williamson ..	V	Black Range Rd	649.7.18		16
P. pedunculata Hook. ..	S	Norton Summit, Mt Lofty Ranges	6310.3.5	16	
P. petiolaris A. Cunn. ex Benth.	Q	Helidon Hills	638.20.4		16
	Q	Kogan	628.3.3, 5		16
P. polifolia A. Cunn. ..	N	Dripstone, near Wellington	628.16.5		16
	N	2 km S. Talbingo	6211.3.8		16
P. procumbens A. Cunn. ..	N	Jenolan Rd above Coxs River	6310.8.12		14
	N	16 km S. Canberra	6210.2.3	7	
	N	2 km S. Talbingo	6211.3.8		14
	N	Waste Point to Sawpit Creek, Kosciusko Rd	6211.2.2	7	14
P. prolifera Williamson ..	V	3 km E. Mt. Richmond	649.8.3, 4		16
P. prostrata Benth. ..	V	24 km W. Horsham, Cooac Scrub	639.9.1		16
	V	7 km W. Dimboola	649.6.6		16
P. pycnocephala F. Muell. ex Benth.	N	Gibraltar Range State Forest, 61 km E. Glen Innes	628.2.8		16
	N	Gibraltar Range State Forest, 61 km E. Glen Innes	6410.1.1		16
P. quadricolor J. M. Black ..	S	1 km W. Mylor, Mt Lofty Ranges	6311.2.1, 2		16
P. recurvifolia (Benth.) Williamson var. *readeriana* (Williamson) Willis ..	V	Victoria Valley Rd, Grampians Ranges	649.7.10		14
	V	Grampians Ranges	6411.2.1		14
P. reticulata (Sm.) Benth. ..	W	Dunsborough, S. Busselton	638.11.1		8
	W	Yallingup, S. Siding Rd	638.11.3		8
	W	S. Witchcliffe turnoff	638.11.6	4	
	W	Brockman Hwy	638.12.5	4	
	W	Manjimup	638.12.7		8
	W	N. Walpole	638.12.8	4	
	W	Emu Point, Albany	638.12.12	4	
P. retusa Sm.	N	Buladelah State Forest	628.14.4, 5	8	16
	N	32 km S. Pt Macquarie	628.15.3		16
	N	16 km N. Newcastle	628.14.1		16
	N	Oakdale	628.20.5		16
	N	Currarong Rd, 8 km S. Nowra	639.5.14		16
	N	2 km W. Huskisson	639.5.9		16
	N	19 km W. Batemans Bay	639.4.8		16
	N	16 km S. Bodalla	6210.1.10		16
P. rosmarinifolia Lindl. ..	N	Woy Woy to Ocean Beach	628.13.3		16
	N	Glenorie	629.1.1		16
	N	Gosford Rd, S. Mt White	648.3.3		16
	N	3 km W. Huskisson	639.5.8		16
P. scabra R.Br.	N	Blaxland	628.21.10		16
	N	Blaxland	639.7.4		16
	N	2 km E. Blackheath	639.10.10		16
P. scabra var. *biloba* (R.Br.) Benth.	N	Colo	627.1.7		16
	N	Lower Portland Ferry	619.3.6		16